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MISSISSAUGA DERAILMENT

GROUND LEVEL CONCENTRATION MEASUREMENTS  
OF CHLORINE AND DETECTION OF OTHER COMPOUNDS

NOVEMBER 1979

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ARB-TDA Report 05-80

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MISSISSAUGA DERAILMENT -  
GROUND LEVEL CONCENTRATION MEASUREMENTS  
OF CHLORINE AND DETECTION OF OTHER COMPOUNDS

A Report Prepared for the  
Ontario Ministry of the Environment

MOE Report ARB-TDA 05-80

By

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## LIST OF SYMBOLS AND ABBREVIATIONS

TAGA™:	Trace Atmospheric Gas Analyser
ug/m <sup>3</sup> :	Weight of compound in ug (10 <sup>-6</sup> grams) per cubic meter of air.
N:	north
S:	south
E:	east
W:	west
MOE:	Ministry of the Environment
MOL:	Ministry of Labour
m:	meters
km:	kilometers
amu:	atomic mass units
m/z:	mass to charge ratio of the ion
Cl <sub>2</sub> :	chemical symbol for chlorine molecule
Cl <sup>-</sup> :	symbol for negatively charged chlorine atom
ppm:	parts-per-million by volume
ppb:	parts-per-billion by volume
eV:	electron volts
s:	seconds
L:	liter
glc:	ground level concentration (measured at a height of 3.6 m during this program)
Hz:	hertz (cycles/s)
ms:	milliseconds
PCB:	polychlorinated biphenyl
TLV:	threshold level value (see Table 1 for definition)
TWA:	time weighted average
CI:	chemical ionization
ng:	nanograms (10 <sup>-9</sup> grams)

## SUMMARY

This report summarizes the activities and the results of an emergency monitoring program performed by SCIEX INC. for the Ontario Ministry of the Environment during the Mississauga train derailment, that is, from November 11 to November 19, 1979. The emergency resulted from a train derailment which produced a large propane fire in close proximity to tank cars leaking chlorine, styrene and toluene into the air. More than 200,000 Mississauga residents were evacuated for their protection against potentially harmful exposure to the chlorine drifting away from the site, and as a precaution against the possibility of further explosions which could release more chlorine. The monitoring was initiated for several purposes: a) to provide concentration measurements of chlorine and other compounds around the site, which could be used as input into decisions regarding the evacuation or eventual resettlement of citizens; b) to ensure that emergency personnel remaining in the area were not exposed to a health hazard from high levels; c) to search for the presence of other potentially hazardous chemicals; d) to provide a record of the extent of contamination for later study.

The monitoring was performed by two Atmospheric Pressure Chemical Ionization Mass Spectrometer Systems (TAGA™), each mounted in a GMC-Transmode van. The TAGA™ 2000 is a manually-controlled system with an analogue output, owned by the Department of Energy, Mines and Resources, while the TAGA™ 3000 is a computer-controlled system with digital output, owned by the MOE. Both systems were designed and built by SCIEX INC. and both were operated during this program by SCIEX staff research scientists.

The features of the TAGA™, which allowed the monitoring to be efficiently performed, are: a) air is sampled and analysed continuously in real time, producing immediate results; b) the minimum detectable level of chlorine is less than  $1 \mu\text{g}/\text{m}^3$ \*; c) chlorine is identified unambiguously by its distinctive pattern of two isotopes; d) the instrument is sensitive to a wide variety of other compounds.

\* The symbol " $\mu$ " in  $\mu\text{g}/\text{m}^3$  will be written as "u" throughout this report.

The TAGA™ units were under the direct control of the MOE regarding where to monitor and which compounds to search for. All information was relayed by radio from the vehicles to the MOE at the Command Center. The monitoring program ran for 24 hours per day from about 14:00 on November 11 to 11:00 on November 19, involving about 160 hours of operation by each system. The TAGA™ requires a vacuum system regeneration period of about six hours after each forty to fifty hours of operation, and these periods were staggered so that one system was always operational. In addition, each required about four hours of other service, scheduled so that one system was always available.

The detailed results of the program are recorded in Section 3. The strategy of the monitoring program was to take advantage of the mobility and real-time response capabilities of the instruments to provide a general characterization of the nature of the chlorine contamination. Chlorine was detected and measured downwind of the site from November 11, when monitoring commenced, until November 17, when the chlorine tank was emptied. In most cases the chlorine was observed to be confined to a ribbon, or plume, ranging in width from one to two hundred meters at a distance of about 0.5 km from the site, to nearly two kilometers at a distance of 4 km from the site (where concentrations were much lower). The horizontal plume dispersion was examined by traversing at varying distances downwind. The vertical dispersion was examined only once (and that only over the lower 4.5 m), and no vertical gradient was observed at that time.

The measurements tabulated in this report are the highest ground level concentrations (glc) encountered during selected traverses of the plume. The levels represent instantaneous concentrations, and so are not directly comparable to time-weighted-average (TWA) exposure levels. Furthermore, the one-dimensional nature of the measurements does not allow a complete characterization of the three-dimensional plume, nor does it allow a mass budget of the chlorine being carried from the site to be inferred. However, the results do show the overall pattern and extent of contamination which occurred, and the measurements did serve as early warnings of changing chlorine concentrations in the air, as well as indicators of the highest chlorine glc's encountered in the plume.

At various intervals, complete positive and negative mode mass scans were performed in the plume, in order to search for the presense of other compounds. The only other compound positively identified in the plume was chloroacetophenone, observed at levels of a few  $\mu\text{g}/\text{m}^3$  or less. Other organics which were tentatively identified on certain occasions, but which were present at levels close to the detection limit of the system, were xylene, toluene, acetophenone, methyl styrene, chlorostyrene, styrene glycol, hydroxyacetophenone, and methyl acetophenone. Detection limits for these compounds are estimated to be in the range of  $10 \mu\text{g}/\text{m}^3$  or less. Other organics which would have been detected if they were present at this level or greater include other chlorinated aromatics (chlorostyrenes), ketones or chlorinated ketones and methylated aromatics. Chlorinated aliphatics would probably have only been detected by the instruments at levels of several hundred micrograms per cubic meter. It appears, based on estimated sensitivities toward these compounds, that the levels of the compounds which were tentatively identified were all below the TLV-TWA values for work-space environments listed in Table 1.

The following conclusions can be drawn about the effectiveness of the monitoring program:

1. The use of two systems was necessary, both to provide a back-up when one system was being recycled, and to provide one system to monitor chlorine levels while the other searched for the presence of other compounds, investigated reports of odors, or looked for other outbreaks of chlorine from the site. The use of two systems also allowed the plume dispersion to be observed, by traverses at different distances downwind.
2. The ability of the systems to measure the levels of chlorine instantaneously and continuously was necessary because of the rapidly changing levels encountered on occasion, either due to events occurring at the site of the derailment, or because of wind fluctuations. It also allowed rapid surveys for chlorine to be performed while the vehicle travelled around the site.



3. The radio communication system, used to relay information from the mobile TAGA™ systems to the MOE at the Command Center, performed well. At no time was important information delayed in being transmitted.
4. The approximate calibration for chlorine, which was initially available because of previous circumstances, allowed levels of chlorine to be approximately quantitated as soon as monitoring commenced. The more accurate calibration (performed in less than an hour on November 14), which was necessary to verify the figure, differed by only 40%. The values recorded until that time were therefore of sufficient accuracy to provide a basis for decisions on potential health hazards.
5. The cooperation between officials at the Command Center (the Ministry of the Environment, the Atmospheric Environment Service and other Government agencies) and the personnel in the vehicles, who were doing the actual measuring, ensured that optimum use was made of the available facilities, and that the ground level chlorine was observed and characterized at all times. From the summary of the data recorded in Chapter 3, it appears that no outflow of chlorine from the site went undetected after the monitoring commenced at about 14:00 on November 11.

In conclusion, the monitoring program appears to have been effective in providing data in real time which could be used to make decisions regarding how to protect citizens and emergency personnel from injury. Furthermore, the data may be useful in studying specifically the spread of chlorine from a point source, under the meteorological conditions which were encountered during the emergency. Future situations may benefit from a detailed study not only of the data, but of the entire protocol of monitoring, and of managing the emergency procedures.

## 1. INTRODUCTION

### 1.1 BACKGROUND

Just before midnight on Saturday, November 10, 1979, a derailment occurred involving 24 railway tanker-cars of a 106-car Canadian Pacific Railway train at the Mavis Road crossing in the city of Mississauga, Ontario (see Figure 1 for a map of the area). One tanker contained 90 tons of liquid chlorine, which began to leak. Of the other cars, eleven contained propane, three contained styrene, three toluene, four caustic soda, and two were boxcars containing insulation. Propane from the ruptured tanks was ignited, resulting in a fire which burned for several days, and which interfered with access to the cars containing the chemicals. Emergency measures were implemented by Canadian Pacific, and the Peel Regional and Mississauga police and firefighters were alerted. Residents were evacuated from the surrounding area in stages, and by the evening of November 11, more than 200,000 citizens had left the area.

Concurrently, the Ministry of the Environment (MOE) initiated a program to measure chlorine and other compounds in the area around the derailment, and at 8:00 on November 11, approached SCIEX INC. with a request to use two mobile TAGA™ systems as the monitoring instruments. The TAGA™ was chosen because of the system's ability to continuously measure very low concentrations of gases in air. One of the TAGA™ systems (the TAGA™ 3000) is owned by the Ministry of the Environment, and at the time was involved in a program of monitoring the levels of PCBs in stack gas from a cement kiln. The other TAGA™ system (the TAGA™ 2000), owned by the National Department of Energy Mines and Natural Resources, and mounted in a vehicle owned by SCIEX, had just returned from an extensive monitoring program and series of experiments in Alabama, Maryland, and at the Environment Protection Agency in Raleigh, North Carolina. Neither was prepared for a monitoring operation; however, both systems happened to be available for use on short notice. Furthermore, the TAGA™ 2000 had coincidentally been used to characterize a mixture of gases, one of which was chlorine, while in North Carolina during the previous week. By reanalysing the data, it was possible to establish an

approximate response factor (calibration) for chlorine until a more accurate calibration could be performed. Both vehicles were, therefore, hastily prepared and restocked, and the systems briefly tested. By 13:00 on November 11, both had been driven to Command Center (the Bell Telephone Center on Mavis Road, about 0.5 km north of the derailment - see Figure 1) At 14:00, after final preparations were completed, and instructions received from the Ministry of the Environment officials, the systems (operated by SCIEX staff research scientists) commenced monitoring for chlorine.

## 1.2 OBJECTIVES

The objectives of the monitoring program were:

1. To ensure that the citizens and emergency personnel were not exposed to hazardous levels of chlorine, by measuring maximum concentrations of chlorine in the plume to provide a worst-case characterization of exposure levels.
2. To ensure that citizens and emergency personnel were not exposed to other potentially hazardous gases, by analysing the air for the presence of a variety of other compounds.
3. To ensure that the spread of chlorine away from the site was monitored, and that all ground level routes of diffusion and convection were known.

## 1.3 TASKS

The specific tasks designed to meet these objectives were:

1. To monitor chlorine levels downwind of the site, and at other locations specified by the MOE.
2. To investigate citizen reports or concerns about strange odors or suspected pockets of chlorine, under the direction of the MOE.

3. To search for the possible presence of other compounds, by performing positive and negative mode mass scans in the plume. These compounds may have been of primary origin (coming directly from a ruptured tanker) or of secondary origin (produced by reactions between escaping chemicals).
4. To report all information to the MOE, including chlorine concentrations, plume locations and widths, unusual odors, new compounds detected, or any other relevant or useful information.

Plume monitoring was performed by traversing the plume on cross-streets downwind of the site. Local meteorological data (wind speed and direction) was obtained by radio from the Ministry of the Environment, and was useful in tracking the plume as it shifted with the wind. During periods of low wind, monitoring excursions were performed around the site to ensure that no unknown outflow of chlorine was occurring from the source.

On at least three occasions, one of the TAGA™ systems was sent by the MOE to locations of reported odors. At the specified location, complete positive and negative mode mass scans were acquired and examined immediately for the presence of unusual mass peaks. These investigations were performed in cooperation with the Ministry of Labour who responded to many other complaints using other measurement techniques.

#### 1.4 USE OF DATA

All of the data was permanently recorded as it was obtained. The signal from the TAGA™ 2000 was recorded continuously on a strip chart recorder, showing chlorine concentrations as a function of time and position. The signal from the TAGA™ 3000 was displayed continuously on the terminal screen, and the values saved by either copying them in a log book, or acquiring a hard copy of the data on the screen.

The data was used in two way:

1. To provide measurements of the chlorine levels to the MOE in real time (as the data was obtained) for the objective previously described.
2. To provide a permanent record of the data for later access and reference.

### 1.5 THRESHOLD LEVEL OF CHLORINE

The chlorine levels measured during the program were used by the Ministry of the Environment to judge the potential effect on human health. The approximate concentration/dosage levels used by the MOL and MOE in making the judgements were supplied to the press on November 15, by the MOL and the MOE, and are listed below for reference, as time-weighted average values:

0.001 ppm or 3 ug/m<sup>3</sup> and below: background level.

0.01 ppm or 30 ug/m<sup>3</sup>: some discomfort for certain individuals.

1.0 ppm or 3000 ug/m<sup>3</sup>: the maximum eight-hour-average occupational standard for exposure.

3 ppm or 9000 ug/m<sup>3</sup> for 15 minutes: Short-term health effect but no long-term damage.

900 ppm or 2,700,000 ug/m<sup>3</sup>: Lethal level.

All of the above thresholds, with the possible exception of the last, apply to average concentrations over some extended period of time. Each of the chlorine concentrations listed in this report is, on the other hand, the nearly instantaneous maximum level encountered during one pass through the plume. The concentrations in the plume were observed to fluctuate widely with time at each point in space, therefore an average level in the plume would probably be lower by at least a factor of two to three than the maximum recorded during one traverse. Furthermore, even under conditions of steady wind, the plume

meandered slowly during a period of several hours (over a distance of several hundred meters on Highway 5, for example). In periods of changing winds, the plume shifts were much larger. The concentration at a stationary (ground-level) point in space downwind of the site would vary between less than  $1 \text{ ug/m}^3$  and the maximum level, reaching the latter perhaps only a few times during a period of several hours. The time-weighted-average (TWA) concentration over a period of an hour or more would therefore be expected to be much lower than the maximum levels recorded during each plume traverse. This discussion emphasizes that the instantaneous concentrations measured during the monitoring program were only intended as "worst-case" characterizations of the chlorine levels in the plume, and can only be related to average exposure levels and to the threshold levels listed above with a full awareness of the variational nature of the plume.

The monitoring procedure, operation of the instruments and calibration procedure are all described in more detail in the next section.

## 2. ANALYTICAL METHODOLOGY

### 2.1 THE TAGA™ SYSTEM

The TAGA™ 2000 and the TAGA™ 3000 are both Atmospheric Pressure Chemical Ionization Mass Spectrometer (APCI/MS) systems, with similar ion source geometries and operating characteristics. The TAGA™ 2000 is an analogue system in which data is recorded on a strip chart recorder, while the TAGA™ 3000 is a digitally controlled system in which the data is collected by a minicomputer, and can be displayed, stored and manipulated in a variety of ways.

Figures 2 and 3 show views of the van and of the TAGA™ 3000 system inside, and Figure 4 shows a schematic drawing of the TAGA™ system. The technique involves drawing a high volume flow of ambient air continuously through the ionization chamber. The trace sample molecules are ionized by ion-molecule reactions with ions created in a corona discharge, and are sampled by drawing them into a vacuum chamber where they are mass analysed with a quadrupole mass spectrometer. The technique is specific, in that only molecules which react with a particular set of reagent ions are detected, as well as sensitive, since the reaction rates are usually very fast. The TAGA™ is mounted in a 26' GMC Transmode van, and powered from two 6 kW Onan generators. The only consumables are ultrahigh purity nitrogen and electric power, and the instrument can be operated continuously for approximately forty hours before a six hour shutdown is required for regeneration of the cryogenic vacuum system (an automatic process).

Detection and measurement of trace gases in air can be performed continuously and in real time (instantaneously). A typical monitoring procedure involves drawing air continuously through a glass sampling line which extends through the roof of the vehicle, and recording the real-time levels of the compound or compounds of interest. The high flowrate (1 L/s) minimizes wall adsorption and memory effects, resulting in a rapid response to a change in concentration at the inlet (a fraction of a second). Since the instrument can be operated while the vehicle is in motion, the system is ideally suited for the application reported herein, that is, for monitoring low levels of a compound in the air under rapidly changing conditions.

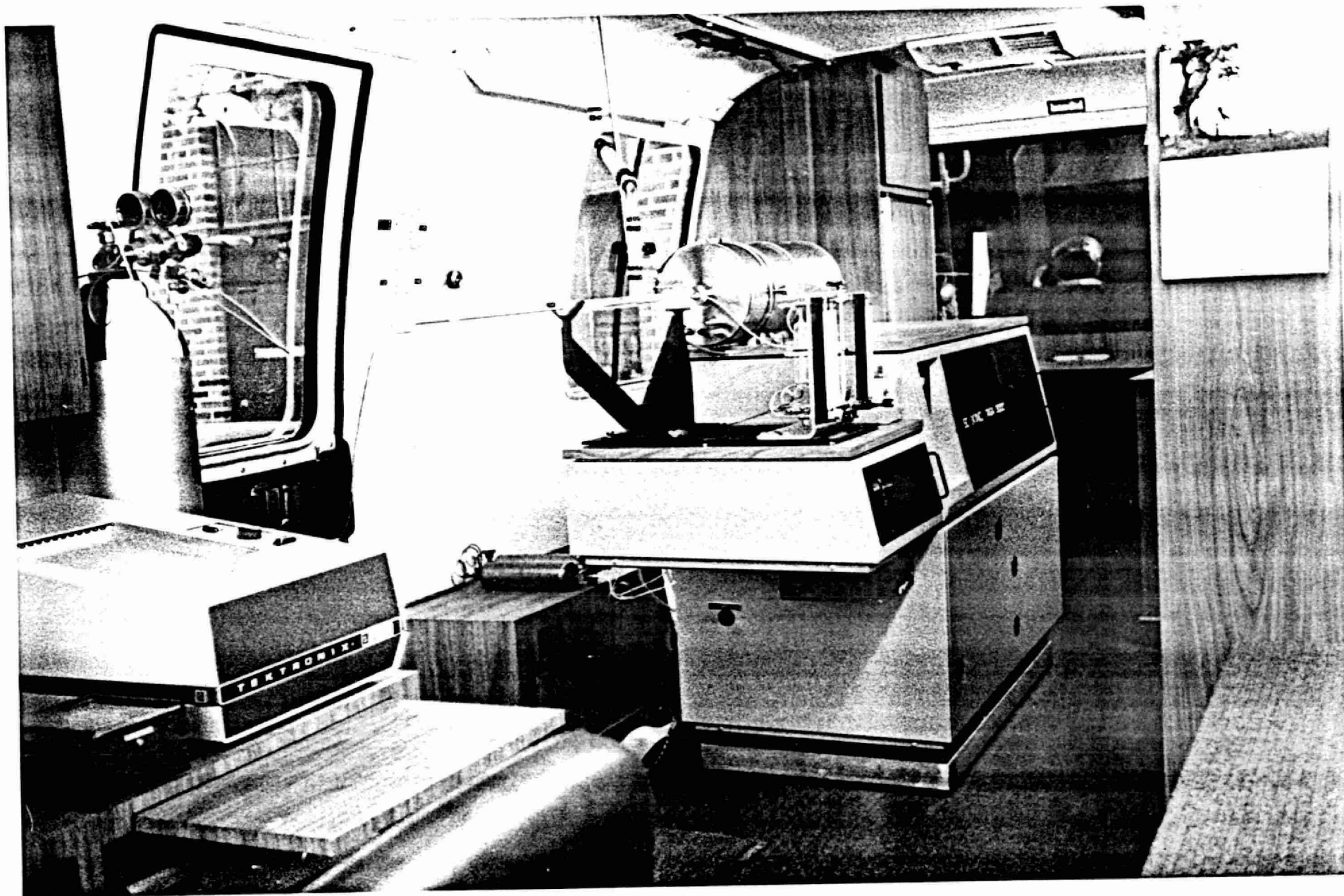
FIGURE 2





MOE - TAGA 3000  
EXTERIOR

FIGURE 3



MOE - TAGA 3000  
INTERIOR

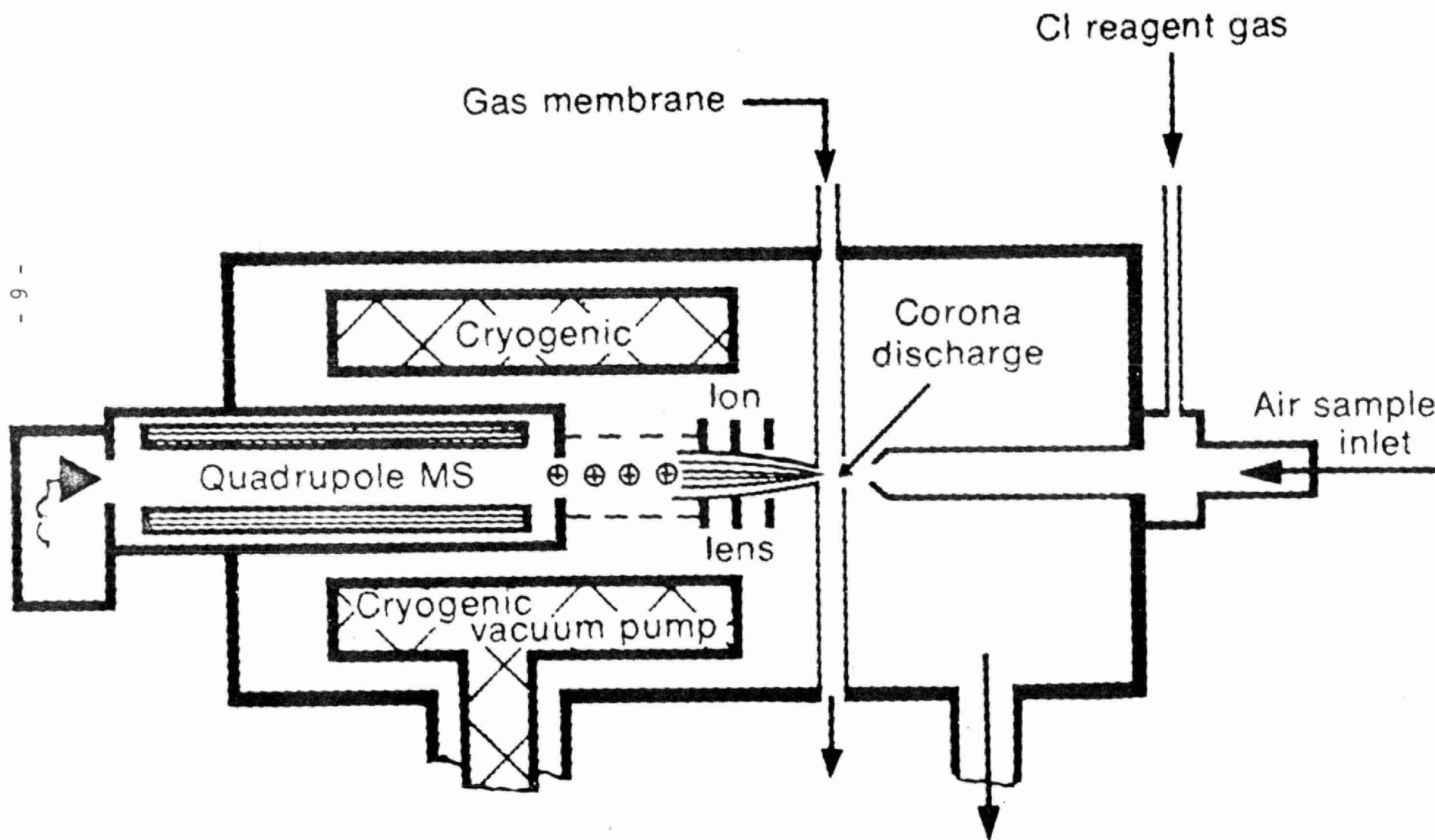
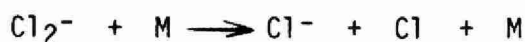


Figure 4. Schematic of TAGA™ System. No Cl reagent gas was employed for this program.

## 2.2 CHLORINE ION CHEMISTRY

Chlorine is detected in the negative mode. The reagent ions generated in the ambient air react with chlorine to produce both  $\text{Cl}_2^-$  and  $\text{Cl}^-$ . Both ions are stable in the air, and both can be observed with the TAGA™. However, as the  $\text{Cl}_2^-$  ions pass from the ionization chamber into the vacuum chamber, they can be broken up (fragmented) by collisions with neutral molecules:



This fragmentation is under operator control, and can be increased or suppressed (allowing both  $\text{Cl}_2^-$  and  $\text{Cl}^-$  to be observed). However, the fragmentation effectively concentrates the total ion signal due to chlorine into one mass channel (that of  $\text{Cl}^-$ ), which increases the sensitivity (signal-to-noise ratio), by a factor of three to five. Therefore, monitoring was performed by selected ion monitoring at the  $\text{Cl}^-$  m/z (mass-to-charge ratio) of 35.

One consequence of this choice was a reduced specificity toward chlorine. The  $\text{Cl}_2^-$  ion at m/z = 70, 72 and 74 (two isotopes of chlorine result in three mass peaks because of the three possible combinations) is a highly specific indicator of the presence of chlorine. However, the  $\text{Cl}^-$  ion can be produced in the ion source from other (mainly low molecular weight) chlorinated hydrocarbons. Therefore, although monitoring was performed by using the  $\text{Cl}^-$  ion as an indicator, occasional (two or three times per day) checks were made to ensure that the source of this ion was chlorine gas, and not some other chlorinated compound, by reducing the fragmentation in order to observe the  $\text{Cl}_2^-$  ion. In fact, even under the high fragmentation operating conditions, the  $\text{Cl}_2^-$  ion was visible in the mass spectrum whenever concentrations were above about 50 ug/m<sup>3</sup>. One further consequence of using  $\text{Cl}^-$  as an indicator of the presence of chlorine, was that it also acted as an indicator for other chlorinated hydrocarbons. Therefore, if other chlorinated compounds had been present, they would have been detected by the signal at  $\text{Cl}^-$ .

Figure 5 shows two mass spectra obtained with the TAGA™ 2000 in the plume, one under high fragmentation conditions and one under low fragmentation conditions. The two spectra represent different levels of chlorine, so that a direct comparison of peak heights is not possible.

## 2.3 CALIBRATION

Up to the time of the request for a monitoring program in Mississauga, the TAGA™ had not been directly calibrated for chlorine, although it was expected that the sensitivity should be rather high. However, in the week previous to the spill, SCIEX participated in a series of experiments at Research Triangle Park, North Carolina, during which a mixture containing a known amount of  $\text{Cl}_2$  (plus other chlorinated compounds) was analysed with the TAGA™ 2000. The response to the mixture was measured at that time at  $m/z=35$  ( $\text{Cl}^-$ ), giving a total chlorine measurement. The results of this experiment were therefore used as an approximate chlorine calibration during the first part of the monitoring program, until a sample of chlorine gas could be obtained and used for direct calibration (at 21:00 on November 14).

### 2.3.1 Preliminary Calibration Technique

The mixture of chlorinated compounds analysed at R.T.P., North Carolina, contained  $\text{Cl}_2$ , chlorobenzene, tetrachloroethylene and dichloroethane in the following relative concentrations: 100:13:35:35. Since each of these could produce a  $\text{Cl}^-$  product, and the response factors for each could be different, only a lower limit could be placed on the response factor for  $\text{Cl}_2$  (by assuming that the response at  $\text{Cl}^-$  was due only to  $\text{Cl}_2$ ). (The response factor multiplied by the peak height equals concentration.) This means that only a lower limit could truly be established for each measurement of an unknown concentration. However, from a knowledge of the other chlorinated compounds in the mixture, and their relative concentrations, it was expected that the actual response factor would very likely not be higher by more than a factor of three, and probably by a factor of two or less, than the lower limit. Therefore, the lower limit calculation was used to measure all concentrations until approximately 21:00 on November 14, when a direct calibration with a certified chlorine gas sample was performed.

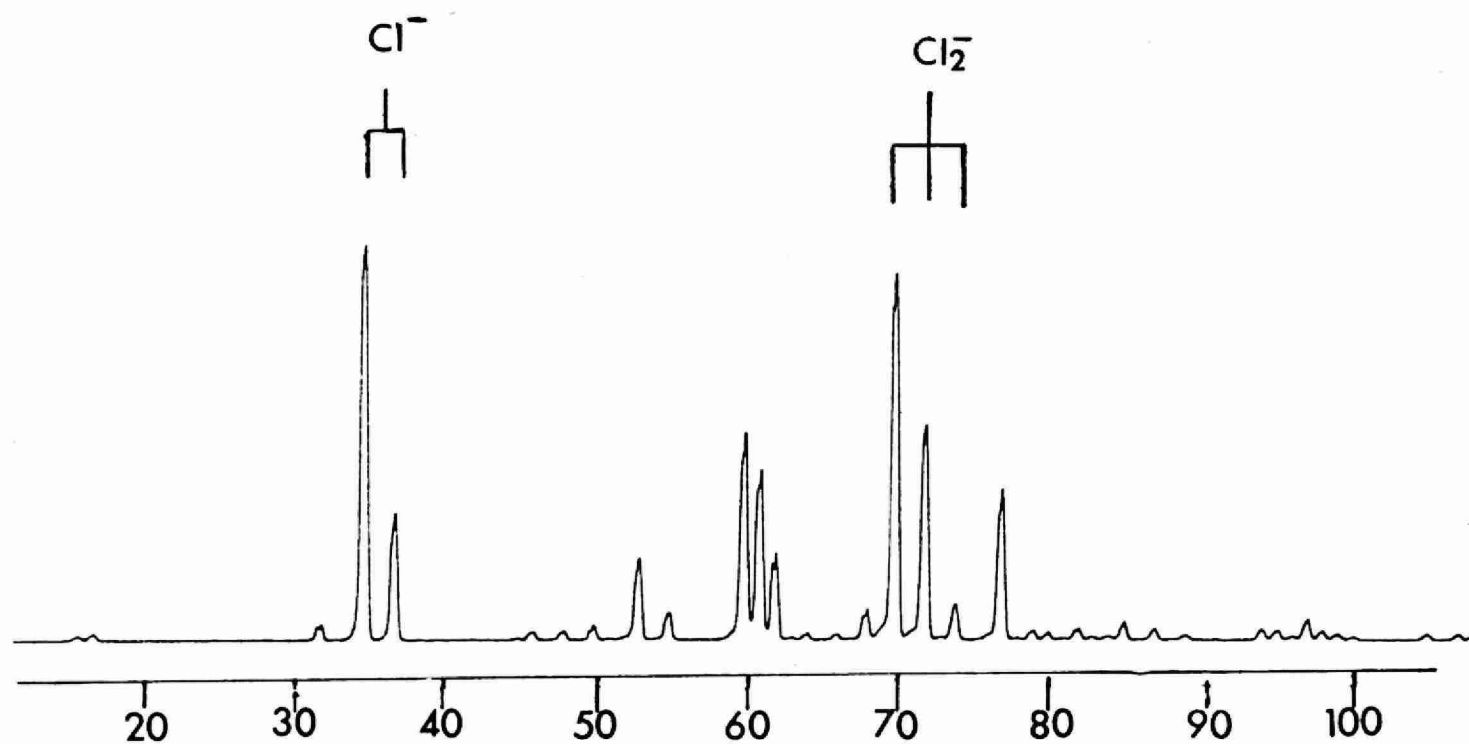
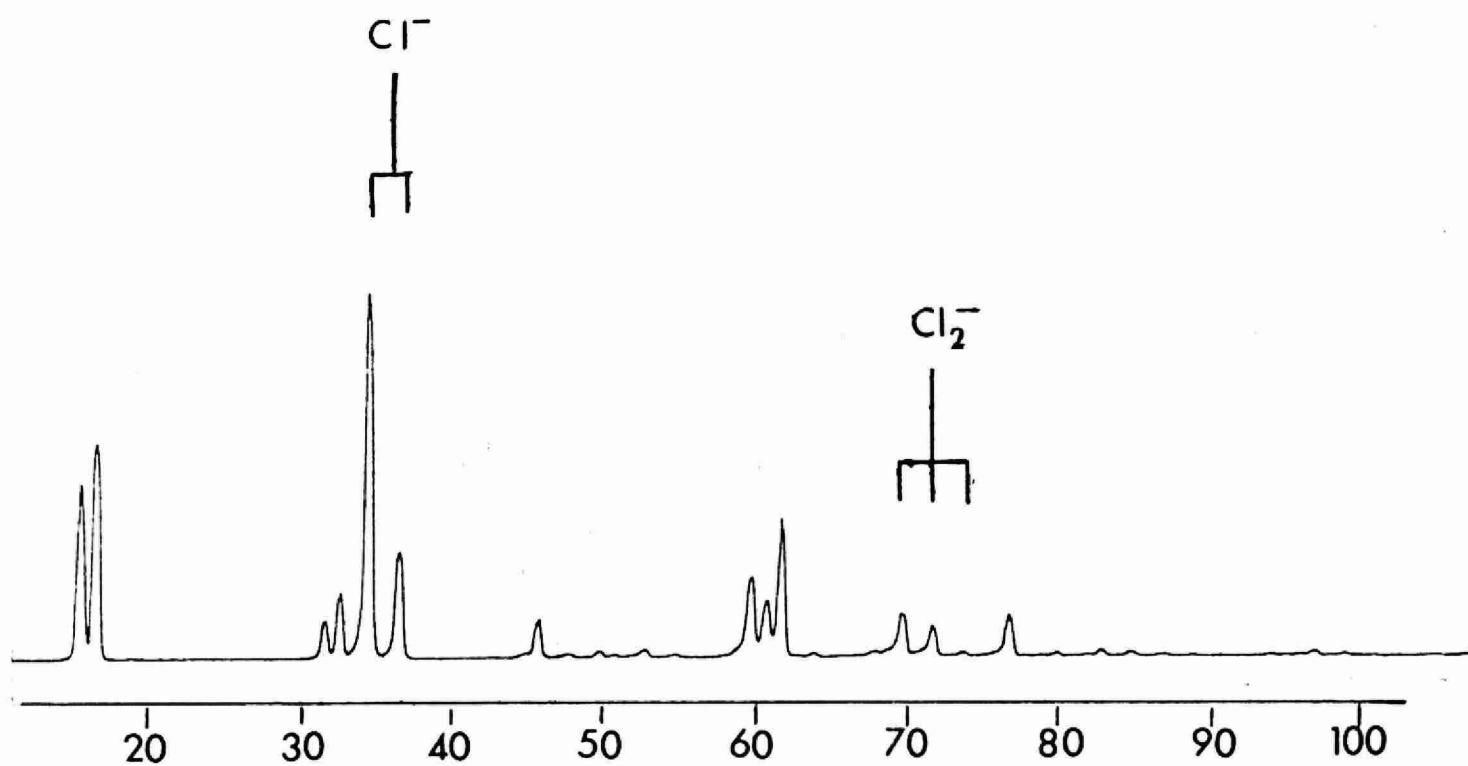


Figure 5. Mass Spectrum obtained in the plume under a) high declustering and b) low declustering conditions.



Throughout the program, the TAGA™ 3000 was calibrated by parking the vehicle next to the TAGA™ 2000, and measuring the average response at Cl<sup>-</sup> over a period of ten to twenty seconds. Using the TAGA™ 2000 response factor to calculate the Cl<sub>2</sub> concentration, the TAGA™ 3000 response factor was calculated. This cross calibration was checked several times during the nine day program.

### 2.3.2 Calibration With Cl<sub>2</sub> Sample

On November 14, a cylinder containing a mixture of Cl<sub>2</sub> in nitrogen (3.94% certified) was obtained from Matheson Gas Company, and a calibration performed between the hours of 21:00 and 22:00 with the TAGA™ 2000, while it was parked on Hwy 5 near Mason Heights. The calibration was performed by filling a gas-tight syringe with the Cl<sub>2</sub> gas (outside the vehicle), bringing the syringe immediately into the van, and using a motorized syringe drive to inject the syringe contents at a known rate into the air flow. The concentration can then be calculated from:

$$C \text{ (ug/m}^3\text{)} = \frac{m \cdot \frac{1}{V} \cdot \frac{dV}{dt}}{F}$$

where  $m/V$  is the mass density of Cl<sub>2</sub> in the syringe,  $F$  is the air flowrate in m<sup>3</sup>/s and  $dV/dt$  is the syringe drive rate in m<sup>3</sup>/s. Three concentrations were produced with three syringe drive rates with the 50 uL syringe, and five higher concentrations were produced with a 10 cc gas tight syringe with a teflon needle. An equation of the form  $R=A(1-e^{-kC})$  has been fitted to the data points, and is plotted in Figure 6 (where  $R$  is the measured signal,  $C$  is the concentration, and  $A$  and  $k$  are adjustable parameters). The equation is of the form predicted by the chemical kinetic model of the TAGA™ ionization source. The response is linear in the range of about 0.1 ug/m<sup>3</sup> (the approximate detection limit) to 100 ug/m<sup>3</sup>, and begins to saturate at about 2000 ug/m<sup>3</sup>.

The instrument accuracy is estimated to be +30% for concentrations below 100 ug/m<sup>3</sup> (because there was no time for repeated injections of the standards), +50% between 100 and 400 ug/m<sup>3</sup>, and not quantitative above 400 ug/m<sup>3</sup>. The inability



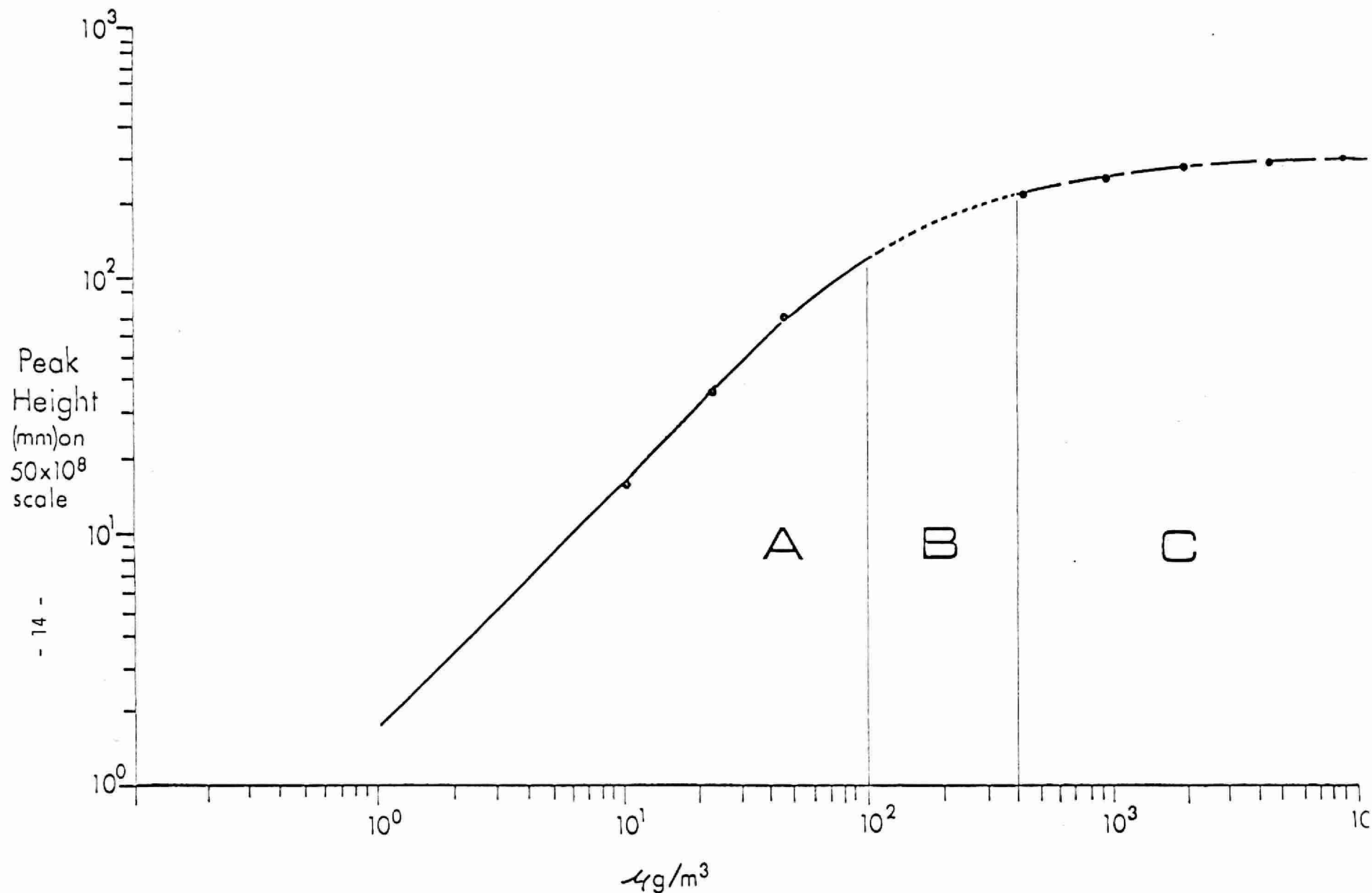


Figure 6. Response (of the TAGA™ 2000) as a function of chlorine concentration, in  $\mu\text{g}/\text{m}^3$ . A: region where accuracy is estimated as  $\pm 30\%$ . B: region where accuracy is estimated as  $\pm 50\%$ . C: region where accuracy is unknown.

to provide quantitation above this level is due to the large error inherent in attempting to read a concentration from the curve where the slope is so low. Much higher concentrations could have been measured with acceptable accuracy if required, however, by diluting the incoming air with ultrapure air (contained in a cylinder on-board the vehicle) to reduce the actual chlorine concentration entering the ionization region. (The response would then have been linear again, and would, when multiplied by the dilution factor, have given the correct concentration.) Since the dilution would also have raised the detectability limit, and since the levels only occasionally and very briefly rose above  $400 \text{ ug/m}^3$  in the plume, this method was not required.

The response factor in the linear portion of the calibration curve (where virtually all of the measurements occurred) is higher by a factor of only 1.44 than the lower limit response factor which was used for all concentration measurements before the calibration. The new response factor was used to calculate all concentrations reported to the MOE after 22:00 on November 14, and has been used to calculate all concentrations recorded in this report.

#### 2.4 MONITORING PROCEDURE

Both the TAGA™ 2000 and the TAGA™ 3000 were used to monitor the chlorine levels at various locations around the site. Both vehicles sampled air continuously at about 1 L/s through a glass tube, the entrance to which was located 0.6m above the top of the van or about 3.6m above the ground. Both vehicles were usually in motion while monitoring. The instructions usually requested monitoring along a specified street, or around a circuit. The vehicle speeds were maintained as constant as possible during a plume traversal, but the speed varied with the situation and the driver. In general, traverses were performed at speeds between 10 to 20 km/hr.

The safety of the operators was ensured by maintaining full Scott Air Packs in each vehicle during the program, ready for instant use in case the chlorine concentrations rose above the tolerable level. The thirty minute air supply in each air

pack would have allowed sufficient time for escape in the event of a sudden and hazardous increase, and also would have allowed traverses across the plume to be maintained while the levels were high, if this was required. The air packs were used only once, briefly, in the TAGA™ 2000, when some minor discomfort was experienced in the center of the plume (during the night of November 12).

The TAGA™ 2000 was operated primarily in the selected ion monitoring (SIM) mode at  $m/z=35$ , with high declustering to provide maximum signal at  $Cl^-$  (see Section 2.2), and data was recorded on a strip chart recorder. This vehicle was used to traverse the plume along various streets downwind of the spill site. With the chart recorder running continuously, a plume profile (a plot of  $Cl^-$  intensity versus time) was generated each time the vehicle passed through the plume. By marking the positions of cross streets (or landmarks) on the chart, and knowing the speed of the chart paper and the speed of the vehicle, the plume position could be located and a horizontal distance scale applied.

The TAGA™ 3000 was used to monitor the level of chlorine (also with high declustering) by repeatedly scanning between 34 and 36 amu (atomic mass units), and using a fixed cursor to trigger the computer to print the intensity (in ions/s) at  $m/z=35$  each time the scan passed that  $m/z$  value. Each intensity was listed on the terminal screen, generating a list of numbers corresponding to a measurement of the  $Cl^-$  level about once every 10 seconds. After the screen was full, a copy was taken.

The ion signal at  $m/z=35$  was converted to a chlorine concentration as the data was produced, by multiplying by a response factor calculated from the calibration curve. In general the maximum concentrations recorded on each plume traverse, and the location of the maximum were reported by radio to the MOE at the Command Centre. At the Command Center, the TAGA™ real-time concentration data were integrated with wind speed and direction data relayed from Toronto International Airport by AES. On-site meteorological data were also acquired by the MOE, and have been published by the MOE in a separate report (Ref.1).

In addition to performing plume traversals, each vehicle was occasionally parked in the plume, and used to continuously monitor the  $Cl_2$  level at one position in space as a function of time.

## 2.5 MONITORING FOR POLYCHLORINATED BIPHENYLS (PCBs)

Because there were initial concerns that PCBs may have been present on the train, the air was analysed for the presence of PCBs downwind of the site on November 11. The TAGA™ 3000 was prepared for detecting PCBs as soon as it arrived at the Command Center at 13:00. The monitoring technique has been previously described in detail (Ref.2). A measurement of the two-minute average concentrations of up to four discrete PCB compounds can be obtained approximately once every four minutes.

The system was calibrated by injecting known concentrations of PCBs into the sampled air, and then filtering the exhaust gas with activated charcoal to remove the PCBs before venting the air. After calibrating, monitoring was started at about 15:30. The monochloro-, dichloro-, trichloro- and tetrachloro- biphenyls were monitored simultaneously as the vehicle travelled slowly in a large circle around the derailment site taking one measurement every four minutes. The detection limits (defined as three times the standard deviation of the backgrounds) for the four compounds were:

<u>Compound</u>	<u>Detection Limit</u>
monochlorobiphenyl	25 ng/m <sup>3</sup>
dichlorobiphenyl	15 ng/m <sup>3</sup>
trichlorobiphenyl	10 ng/m <sup>3</sup>
tetrachlorobiphenyl	5 ng/m <sup>3</sup>

No PCBs were detected above the detection limits. It later was learned that PCBs were not being carried on the train.

## 2.6 IDENTIFICATION OF OTHER COMPOUNDS

On various occasions, complete positive and negative mode mass scans were taken in the plume and outside the plume in order to search for the presence of compounds other than  $\text{Cl}_2$ . These scans also provided the opportunity to positively confirm that the source of  $\text{Cl}^-$  was  $\text{Cl}_2$ , by scanning under low cluster-breaking conditions. In addition to searching for other compounds in the plume, citizen concerns about strange odors were investigated by performing complete mass scans at the site of the odor, and looking for unusual peaks in the spectra. These scans were performed under various conditions of declustering, depending upon the type of odor reported (a search for  $\text{H}_2\text{S}$ , for example, was performed in the negative mode by looking for  $\text{HS}^-$  at  $m/z=33$ , operating with reduced declustering in order to eliminate the interference from  $\text{O}_2\text{H}^-$ , a common fragment).

The one other compound which was positively identified and shown to be associated with the plume, was  $\alpha$ -chloroacetophenone (chloromethyl phenyl ketone). This compound was first observed during a positive mode mass scan on the morning of November 12, at a time when strong eye irritation was noted in the downwind plume. Thereafter, occasional checks for the presence of this compound were made by traversing the plume while monitoring  $m/z=155$  ( $\text{MH}^+$  of the largest isotope of chloroacetophenone).

A few other compounds were tentatively identified from the spectra obtained in the plume, and are listed in Section 3.2. All gave smaller responses than did chloroacetophenone. The chlorinated aliphatics are not sensitively detected by the TAGA<sup>™</sup> with ambient air chemical ionization. Detection limits for these are probably in the range of tens to hundreds of parts-per-billion. Most would only be revealed as  $\text{Cl}^-$ , and so would not show up separately from the chlorine. Sensitivity is higher to aromatics and substituted aromatics, and to compounds containing an oxygen or a nitrogen atom. Alpha-methyl styrene for example can be detected in clean air at about 0.5 ppb. The

detection limit for styrene is probably of the order of a few parts-per-billion. No calibration was performed for any of the minor organic species detected, as the amounts detected appeared to be too small to warrant special monitoring procedures. Therefore, no estimate can be placed on their concentration. However, most were present only slightly above the detection limit of the instrument, and their identification (from the mass of the ion) is only tentative. Table 1 shows a list of some of the compounds which were tentatively detected, and some which might have been expected to be present, along with the TLV (Threshold Level Value) when available and estimated TAGA™ detection limit for each.

## 2.7 COMMUNICATION OF RESULTS TO THE COMMAND CENTER

Both TAGA™ vehicles were in continuous radio contact with the MOE vehicle at the Command Center throughout the program, allowing rapid feedback of data. Hand-held transceivers were used when the intervening distances were close enough to allow clear reception (generally 1 to 2 km). When the vehicles were further away, the data was relayed through an operator in a truck (equipped with a more powerful transmitter), who followed the vehicles as they monitored. During the time when the chlorine tank was being pumped out (on November 15th) a police cruiser was assigned to each TAGA™ to provide instant communication (through the police radio) of any unusual measurements in case of failure of the normal communication channel. This backup system was not used.

TABLE 1

REFERENCE TABLE OF COMPOUNDS,  
ACCEPTABLE CONCENTRATIONS IN THE AIR,  
AND TAGA™ DETECTION LIMITS

<u>Compound</u>	<u>TLV-TWA<sup>1</sup></u> (ppm)	<u>TLV-STEL<sup>2</sup></u> (ppm)	<u>TAGA™</u> <u>Detection Limit</u> (ppm-estimated)	<u>Observed By</u> <u>TAGA™</u>
Styrene	100 <sup>a</sup>	125 <sup>a</sup>	0.01	No
α-Chloroacetophenone	0.05 <sup>a</sup>	-	0.0001	Yes
Chlorostyrene	9 <sup>b</sup>	-	0.05	Yes <sup>d</sup>
Xylene	100 <sup>c</sup>	-	0.05	Yes <sup>d</sup>
Toluene	200 <sup>c</sup>	-	0.1	Yes <sup>d</sup>
Styrene Glycol	-	-	0.001	Yes <sup>d</sup>
Acetophenone	1 <sup>b</sup>	-	0.0001	Yes <sup>d</sup>
Butenoic Acid	-	-	0.0001	Yes <sup>d</sup>
Butyric Acid	2.5 <sup>b</sup>	-	0.0001	Yes <sup>d</sup>
Methyfuram	0.27 <sup>b</sup>	-	0.0001	Yes <sup>d</sup>
Methylpyrazole	-	-	0.0001	Yes <sup>d</sup>
Methylacetophenone	-	-	0.0001	Yes <sup>d</sup>
Hydroxyacetophenone	-	-	0.0001	Yes <sup>d</sup>
Dichlorostyrene	-	-	0.0005	No

a: USA Standard - Reference 3

b: USSR Standard - Reference 4

c: USA Standard - Reference 4

d: Compound Identification is tentative

-: Unspecified

1. TLV-TWA is the maximum eight-hour-average concentration to which nearly all workers can be exposed without adverse effect.
2. TLV-STEL (Threshold Level Value - Short Term Exposure Limit) is the maximum concentration to which workers can be exposed for a period of up to fifteen minutes continuously, without adverse effect.

### 3. RESULTS

A large volume of data was recorded during the nine day monitoring program - approximately one hundred and sixty hours of continuous measurements with each instrument. The data have been summarized for this report in two ways.

First, a narrative describes chronologically the activities of each van throughout the program. The approximate location of the vehicle, chlorine levels at that location, and whether any other compounds were observed are all recorded. The time, wind speed (WS) in km/hr and wind direction (WD) in degrees east of north, as measured at the MOE van, which was generally stationed on Hwy 5 until November 13, and at the Command Center on Mavis Road thereafter, are recorded in the margin.

All measurements of the chlorine showed that it was essentially confined to a narrow band downwind of the source which spread as downwind distance increased. The chart record of the TAGA™ 2000 shows a cross-sectional profile (intensity vs distance) of the plume each time the vehicle traversed it, and each value of the chlorine concentration recorded in this report is either the maximum level observed on a particular plume traverse, or else the maximum level during that hour if the van was stationary in the plume. Every traverse showed well defined plume boundaries outside of which no chlorine was detected. The width of the plume ranged from a few hundred meters close to the source, to one to two kilometers at greater downwind distances (on Hwy 2, for example; see Figure 8).

The second type of data summary which is included is a tabular record of hourly locations of the plume maximum, peak chlorine concentration in the plume, whether chloroacetophenone was detected in the plume, and the approximate distance between the source and the position of the plume maximum (on that particular cross-section). Usually only one vehicle was traversing the plume at one time while the other monitored at other locations or investigated reports of odors, so that only one value is recorded for each time. On occasion, however, the vehicles were measuring chlorine at different distances downwind, and in these instances the peak chlorine levels at both positions are recorded.



All of the chlorine values recorded are calculated from the response factor obtained from the calibration performed on November 14. The values are those measured by drawing air in at a height of 3.6 m above the ground. On one occasion (02:00 November 15 on Hwy 5) a flexible sampling line was connected to the inlet, and chlorine concentrations were measured at heights between 4.5 m and ground level. The concentrations were the same at all heights (about  $35 \text{ ug/m}^3$ ), with no indication of higher concentrations near the ground. The wind speed at this time was 1 to 2 km/hr, so that there was unlikely to be strong vertical mixing at the point of measurement. Therefore, the measurements acquired at a height of 3.6 m appear to be representative of chlorine levels within 4 m of the ground.

Figure 7 shows two of the chart records of signal versus time for two consecutive plume traverses (the traverses were performed in opposite directions, so one of the scans has been reversed to make the directions the same). Over the time scale of 140 seconds, the gross features of the plume are preserved. In other instances, however, plume shape and width changed substantially over the space of a minute. Likewise, on certain occasions peak chlorine levels in the plume fluctuated minute to minute by factors of as much as three to five. On other occasions the peak values on consecutive passes were quite constant.

Figure 8 shows the results of three plume traverses at different downwind distances, projected onto a map of the monitored area. The three traverses were performed on November 14 between 5:30 and 6:30, and illustrate the plume-like features of the emission; - that is lateral divergence and decrease of the maximum chlorine glc in the plume with increasing distance from the source. The fine scale features of each profile have been smoothed to illustrate the general plume shape.

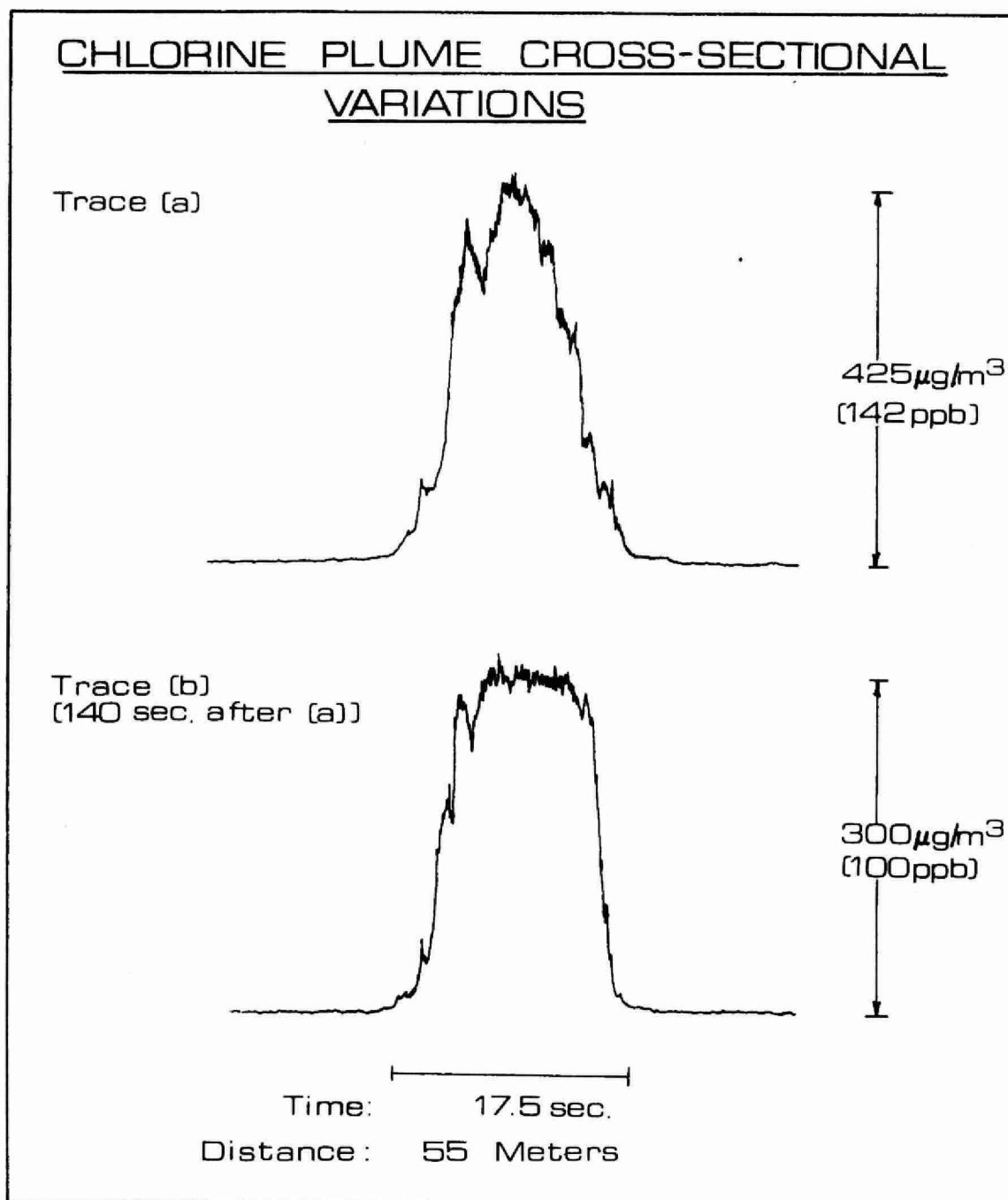


Figure 7. Two consecutive plume cross-sections, acquired 140 seconds apart, showing the fine and broad structure. The fine scale fluctuations represent real chlorine concentration variations, and are not instrument noise.

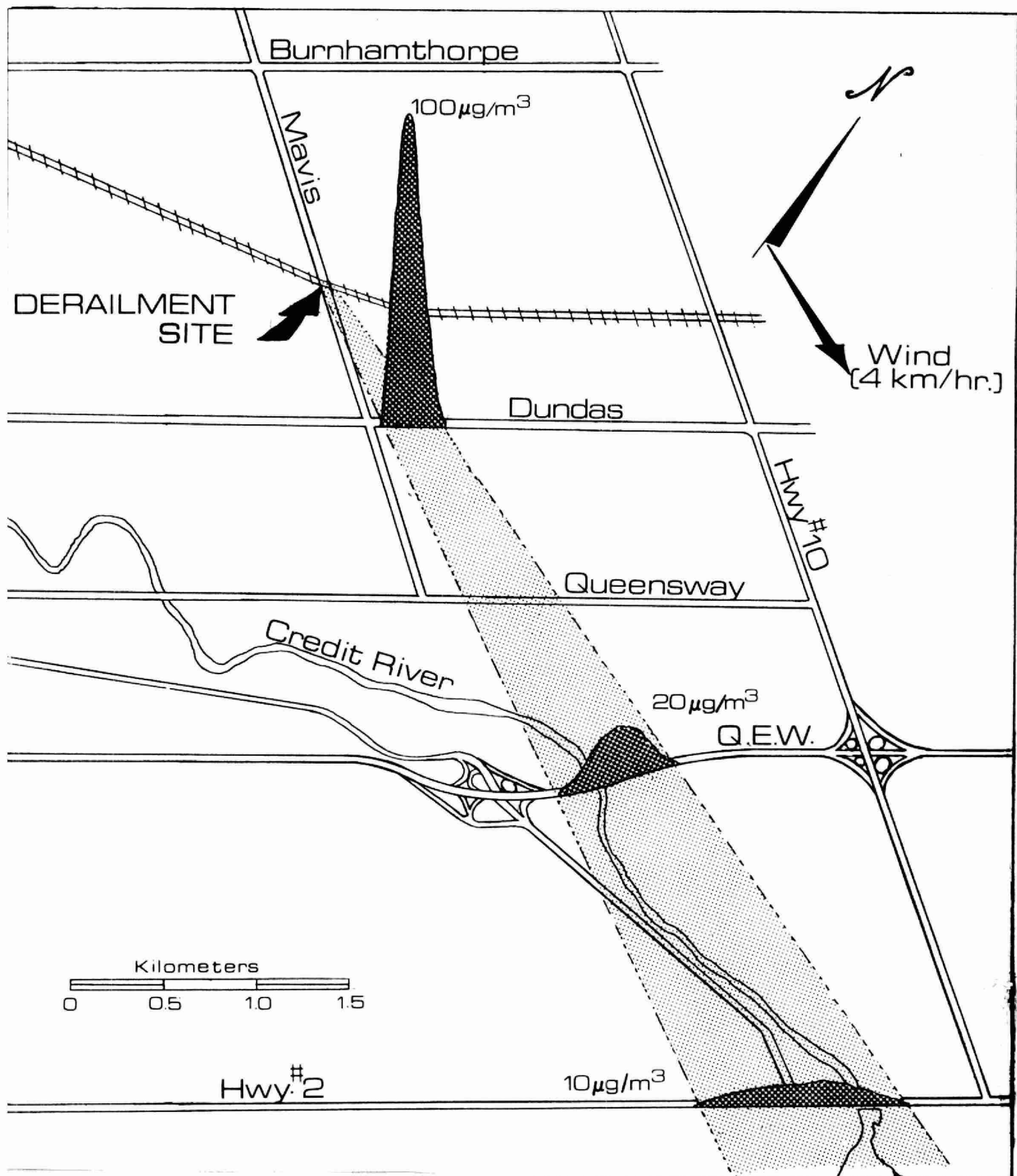


Figure 8. Three plume cross-sections taken between 5:30 and 6:30 on November 14th, 1979.

### 3.1 SUMMARY OF MONITORING ACTIVITIES AND CHLORINE MEASUREMENTS

A map of the monitored area is included for reference to locations (Figure 1).

TIME	WD	WS	November 11, 1979
hrs	deg	km/hr	

After SCIEX received a request to use both the TAGA™ 2000 and the TAGA™ 3000 for continuous monitoring, both systems were prepared and driven to the Command Center. Between 9:00 and 15:00, the TAGA™ 3000 was disconnected from the installation at St. Lawrence Cement, a new sampling line was installed, an air motor (for ambient air sampling) was reinstalled, and the vehicle driven to the site. The TAGA™ 2000 was cleaned, pumped down, tested and driven to the site by 13:00. After final preparation and receipt of instructions from the MOE, the TAGA™ 2000 began monitoring for chlorine, while the TAGA™ 3000 prepared to monitor for PCBs.

14:00	300	17	Between 14:00 and 14:15 the TAGA™ 2000 measured chlorine levels on Burnhamthorpe, south on Hwy 10 to the Queensway, west to Mavis and north to Hwy 5. The chlorine was observed to be confined to a narrow plume (about 250 m wide) crossing the Queensway just east of Mavis. The peak concentration in the plume was 20 ug/m <sup>3</sup> . Between 14:15 and 15:00 the TAGA™ 2000 remained stationary at the weigh scales (just east of Mavis) on Hwy 5, measuring values between 6 and 80 ug/m <sup>3</sup> . At 15:00 the vehicle moved to the intersection of Mavis and Hwy 5, and continued measuring values of between 2 and 63 ug/m <sup>3</sup> , until 17:00.
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17:00	280	12	Between 15:30 and 16:50, the TAGA™ 3000 measured PCB levels while travelling east on Burnhamthorpe, south on Hwy 10, west on the Queensway and north on Mavis to Hwy 5. The monochloro- to the tetrachloro- biphenyls were monitored, with one measurement obtained about every five minutes. No PCBs were observed above the detection limits of between 5 and 20 ng/m <sup>3</sup> (see Section 2.5).
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At 17:00 both vehicles proceeded to the Domtar brick-yard, where they remained until about 20:00. The TAGA™ 3000 was prepared for chlorine monitoring, and a cross calibration

<u>TIME</u>	<u>WD</u>	<u>WS</u>	
18:00	260	8	performed with the TAGA™ 2000. The TAGA™ 2000 continued monitoring in the brickyard, measuring maximum excursions of 35 ug/m <sup>3</sup> at 17:00, 80 ug/m <sup>3</sup> at 18:09, 55 ug/m <sup>3</sup> at 18:34 and 150 ug/m <sup>3</sup> at 18:40. In general however, the level remained between 1 and 10 ug/m <sup>3</sup> . At 19:00, the chlorine level dropped at this location to below the detection limit (nominal 1 ug/m <sup>3</sup> and no chlorine was detected until the vehicles left this site at about 20:00.
20:00	230	7	The TAGA™ 2000 proceeded to Burnhamthorpe, traversing between Hwy 10 and Wolfedale from 20:00 to 21:00. No chlorine was detected. From 21:00 to 24:00 the TAGA™ 2000 continuously traversed Burnhamthorpe between Mavis and Hwy 10, Hwy 10 between Burnhamthorpe and Bloor, and Burnhamthorpe between Hwy 10 and Cawthra. No chlorine was detected. Meanwhile the TAGA™ 3000 traversed Hwy 10 between Burnhamthorpe and the Queensway, extending the southern boundary to Sherobee as the plume moved south. The plume was detected at Hwy 10 and Kerwin at 20:00, and gradually moved south to Hwy 10 and the Queensway by 23:30. Peak values in the plume were between 2 and 5 ug/m <sup>3</sup> . At 24:00, both vehicles returned to the Command Center.
23:00	250	1	

November 12, 1979

02:00	300	6	At 1:00 both vehicles returned from the Command Center to the area downwind of the site. The TAGA™ 3000 monitored the plume on Hwy 5 between 1:00 and 3:00, measuring peak values in the plume of about 15 ug/m <sup>3</sup> or less at 1:30. The plume was located at the intersection of Hwy 5 and Mavis, and remained there until about 6:00 when it started shifting slowly toward the west, until it intersected Hwy 5 at Wolfedale at about 8:00. The peak values on Hwy 5 increased to about 30 ug/m <sup>3</sup> at 2:00, and varied between 20 ug/m <sup>3</sup> and 70 ug/m <sup>3</sup> until about 6:00. Just before 6:00, a large concentration (about 300 ug/m <sup>3</sup> ) was recorded during one pass through the plume. This was not repeated, although the concentration remained at about 75 ug/m <sup>3</sup> , decreasing to 50 ug/m <sup>3</sup> by 06:30. During this time (1:00 to 5:00), the TAGA™ 2000 was traversing the plume on Hwy 5, Paisley, Louis and the Queensway, measuring plume widths of about 140 to 150 m on Hwy 5, and 150 to 170 m on the Queensway. Between 5:00 and 6:00 the TAGA™ 2000 was located on Huron Park, measuring peak values of about 30 ug/m <sup>3</sup> . The single burst of
06:00	015	9	

<u>TIME</u>	<u>WD</u>	<u>WS</u>	
			chlorine registered by the TAGA™ 3000 at 6:00 was not detected at the TAGA™ 2000, which was probably out of the plume at that time. The increase in concentration after 6:00 was recorded however; values of about 60 ug/m <sup>3</sup> were recorded on Hwy 5 between 6:00 and 7:00.

07:00	010	7	The TAGA™ 2000 returned to the Command Center at 7:00, while the TAGA™ 3000 continued monitoring on Hwy 5, the Queensway and the QEW (where a peak value of about 4 ug/m <sup>3</sup> was measured in the plume at 7:50). Between 8:00 and 13:00 the TAGA™ 3000 monitored on Hwy 5 and Wolfedale; peak concentrations remained at about 30 ug/m <sup>3</sup> in the plume, with the plume center shifting from Hwy 5 at Wolfedale at about 8:00 to just south of the Railroad tracks on Wolfedale by 12:00. During the hours of 8:00 to 12:00, all operators noticed strong eye irritation (watering eyes) in the plume. At 10:00, a positive mode scan with the TAGA™ 2000 at Glengarry and Hwy 5 revealed the presence of a mono-chlorinated species (identified by the distinctive isotopes) at m/z=155, 157. The most likely identity is α-chloroacetophenone, a strong lachrymator. This compound was probably formed from styrene and chlorine with a photo-induced oxidation step. Traversal of Wolfedale while monitoring m/z=155 showed that the compound was definitely associated with the plume. During the period from about 10:00 to 11:00, when chloroacetophenone was being detected, the TAGA™ 2000 also measured high levels of Cl <sup>-</sup> in the plume; however, a negative mode mass scan showed relatively low levels of Cl <sub>2</sub> <sup>-</sup> . This suggests that the Cl <sup>-</sup> was formed in the ion source from chloroacetophenone (or its precursors, such as chlorinated styrenes) and that this was the source of Cl <sup>-</sup> detected at that time. Although the TAGA™ 3000 was traversing Wolfedale at the same time, high levels of Cl <sup>-</sup> were not measured by it. No attempt was made at that time to look for chloroacetophenone with the TAGA™ 3000. At about 11:30, the plume was crossed by the TAGA™ 2000 at McBride and Oakglade Crescent (5 ug/m <sup>3</sup> peak value). At 12:00, the TAGA™ 3000 measured a peak value of 14 ug/m <sup>3</sup> on Wolfedale, decreasing to a value of about 4 ug/m <sup>3</sup> by 13:00.
10:00	070	3	
12:00	220	0	

<u>TIME</u>	<u>WD</u>	<u>WS</u>	
			Between 13:30 and 16:40 the TAGA™ 3000 was located in the Domtar brickyard; the maximum chlorine concentration during that time was about 5 ug/m <sup>3</sup> . From 16:40 to 20:00 a vacuum recycle was performed. Meanwhile the TAGA™ 2000 monitored on Wolfedale (3 ug/m <sup>3</sup> about 13:00) and Hwy 5. At 14:00 the TAGA™
13:00	350	0	2000 returned to the Command Center and remained stationary in the parking lot of the cement plant on Mavis directly across from the Command Center until 19:50. From 14:00 to 16:30 the
14:00	170	2	chlorine levels varied between non-detectable (<1 ug/m <sup>3</sup> ) and 60 ug/m <sup>3</sup> as the plume shifted back and forth. Between 16:30 and 19:50 no chlorine was detected at this location. At about 16:00, a fast check revealed the presence of chloroacetophenone in the plume.

20:00	350	0	At 19:50 the TAGA™ 2000 returned to traversing Mavis, Hwy 5 and Wolfedale south of the site. Positive and negative mode scans were performed. At about 22:00, traversals of Wolfedale were commenced, and high chlorine readings noted. The plume was located just south of Forestwood Drive, with chlorine levels corresponding to greater than 400 ug/m <sup>3</sup> . This level
22:00	020	2	was reported as approximately 300 ug/m <sup>3</sup> , because only the preliminary calibration was available at the time. Re-examination of the data showed that the level was above the limit which defines the region of quantitative response. The high readings were recorded on Wolfedale until 23:30 hours, when the level had decreased to about 350 ug/m <sup>3</sup> . (During this time, the response at Cl <sub>2</sub> <sup>-</sup> was also monitored to show that the response was due to chlorine and not to chloroacetophenone.)

24:00	025	3	The TAGA™ 3000, having returned to monitoring at 20:00, recorded a value of about 140 ug/m <sup>3</sup> at 21:00. A break was taken between 21:00 and 23:00. A level of about 350 ug/m <sup>3</sup> was recorded on Wolfedale at 23:30, and about 200 ug/m <sup>3</sup> was recorded at 24:00.
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#### November 13, 1979

During the first hour (00:00 to 1:00) on November 13, both the TAGA™ 2000 and the TAGA™ 3000 were traversing the plume on Wolfedale between the Railroad tracks and Hwy 5. Positive and negative mode mass scans were performed by the TAGA™ 2000 in the plume at about 00:00. The only major contaminant present was chlorine, identified by the presence of both Cl<sup>-</sup> and Cl<sub>2</sub><sup>-</sup> in the spectrum, at a concentration greater than 400 ug/m<sup>3</sup>. The vehicle proceeded onto Dundas, where the peak concentration (at about Cedarglen Gate) was 200 ug/m<sup>3</sup>.



TIME	WD	WS	
01:00	020	3	During this period, the TAGA™ 3000 was monitoring for the presence of chloroacetophenone (in the positive mode) on Wolfedale. None was detected. The TAGA™ 2000 continued monitoring on Hwy 5, measuring peak concentrations of up to 150 ug/m <sup>3</sup> at about Cedarglen Gate between 00:30 and 1:30, while the TAGA™ 3000 was measuring chlorine concentrations of about 100 ug/m <sup>3</sup> 600 m south of the Railroad tracks on Wolfedale. Between 1:30 and about 4:00, both vehicles continually traversed the plume on Wolfedale, measuring peak concentrations of between 100 and 200 ug/m <sup>3</sup> about 500 m south of the Railroad tracks. Plume widths were between 300 and 500 m.
03:00	030	4	

06:00	030	5	At about 4:00 the TAGA™ 2000 traversed the plume on Hwy 5 (measuring a peak of 85 ug/m <sup>3</sup> at Erindale Station Road) and Wolfedale (measuring a peak of 140 ug/m <sup>3</sup> ). From 5:00 to 6:00 the plume was crossed at Stanton and Blairholm (100 ug/m <sup>3</sup> ) Forestwood and McBride (114 ug/m <sup>3</sup> ) and on Hwy 5 between Erindale Station Road and Cedarglen Gate (85 ug/m <sup>3</sup> ). At 6:00 complete mass scans were obtained on Wolfedale outside the plume. No unusual contaminants were detected. Two traverses on Hwy 5 and Wolfedale showed peak concentrations of 170 ug/m <sup>3</sup> on Wolfedale and 85 ug/m <sup>3</sup> on Hwy 5 at Cedarglen Gate (at 6:30). Between 7:00 and 8:00 a circuit of Wolfedale, Westlock, McBride, Erindale Station Road and Hwy 5 showed concentrations of 80 ug/m <sup>3</sup> at Hwy 5 and Cedarglen and 150 ug/m <sup>3</sup> on Wolfedale at Forestwood Drive (at about 7:45). During the preceeding interval (4:00 to 8:00) the TAGA™ 3000 continuously traversed the plume on Wolfedale until 6:00, measuring peak concentrations of about 100 ug/m <sup>3</sup> . Between 6:00 and 8:00, the vehicle completed the circuit from Wolfedale, Westlock, McBride, Erindale Station Road, Forestwood, (or Hwy 5), and Wolfedale a total of four times, crossing the plume on Wolfedale (about 150 ug/m <sup>3</sup> ) and Hwy 5 (about 80 ug/m <sup>3</sup> ). Both vehicles returned to the Command Center at about 8:00.
08:00	030	10	

12:00	355	8	The TAGA™ 3000 returned to Hwy 5 at about 11:00, and measured a Cl <sub>2</sub> level of between 300 and 400 ug/m <sup>3</sup> at Wolfedale and Hwy 5 between about 11:30 and 12:00. Traverses between Hwy 5 and the Railroad tracks showed concentrations of up to 300 ug/m <sup>3</sup> between 12:00 and 13:00. The TAGA™ 2000 returned at 12:40 after a vacuum system recycle, and remained
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<u>TIME</u>	<u>WD</u>	<u>WS</u>	
			stationary on the edge of the plume on Hwy 5 until about 14:00 hours, recording values of up to $120 \text{ ug/m}^3$ . The TAGA™ 2000 then proceeded south on Hwy 10, west on Premium Way, north on Stavebank, west on the Queensway (crossing the plume at Rosemary - $21 \text{ ug/m}^3$ and 1 km wide), north on Glengarry, west on Hwy 5,
15:00	350	7	south on Mississauga Road (crossing the plume at 15:00, 750 m before north Sheridan Way - $7 \text{ ug/m}^3$ and 1 km wide) to Hwy 2. In the meanwhile the TAGA™ 3000 completed a large circuit east of Hwy 10, monitoring along Burnhamthorpe to Cawthra, south to Hwy 2 and north to Hwy 5. No plume was detected until Hwy 5 and Wolfedale, where the peak concentration (at 16:00) was $75 \text{ ug/m}^3$ . Between 16:00 and 19:00 the TAGA™ 3000 traversed the plume on
20:00	310	5	Hwy 5 (measuring peak concentrations of about $75 \text{ ug/m}^3$ near Wolfedale). The TAGA™ 2000 crossed the plume on Hwy 2 ( $1 \text{ ug/m}^3$ at Owenwood), on the QEW at Mississauga Road ( $50 \text{ ug/m}^3$ at about 16:15). The plume was traversed three times on the QEW before returning north on Hwy 10 to Hwy 5 and Mavis ( $100 \text{ ug/m}^3$ just east of Mavis). A complete mass scan was obtained at about 20:00 in the plume, showing both $\text{Cl}^-$ and $\text{Cl}_2^-$ .

Between 20:00 and 24:00 the TAGA™ 2000 crossed the plume on Hwy 5 measuring peak concentrations of 70 to  $100 \text{ ug/m}^3$  east of Mavis. Between 19:00 and 22:00 the TAGA™ 3000 traversed the plume on Hwy 2 north on Southdown, west on Truscott to Winston Churchill and back to Southdown and Hwy 2. At 22:00 the peak concentration in the plume was  $37 \text{ ug/m}^3$  at Hwy 2 and Harrison. Continuous traversals of Hwy 2 between Southdown and Hwy 10 were performed between 22:00 and 24:00. At 23:30 the peak concentration at Hwy 2 and Helen was  $14 \text{ ug/m}^3$ .

#### November 14, 1979

Between 00:00 and 1:00 the TAGA™ 2000 was located at the Command Center. At 00:05 the TAGA™ 3000 was sent to 3551 Nadine to investigate the report of an odor. Positive and negative mode scans were obtained. No chlorine was detected ( $< 1 \text{ ug/m}^3$ ), and no other compounds were detected above background levels. Another request was answered at Juanita Court and Michelle Row at 00:25. No chlorine or other compounds were detected.

<u>TIME</u>	<u>WD</u>	<u>WS</u>	
01:00	310	2	<p>At 1:00 the TAGA™ 2000 returned to traversing Hwy 5 between Wolfedale and Stillmeadow. A level of 200 ug/m<sup>3</sup> was recorded at 1:00, with subsequent traverses recording levels between 100 and 200 ug/m<sup>3</sup>. A circle was then made south of Mavis to the Queensway, east on the Queensway where a level of 40 ug/m<sup>3</sup> was recorded to Gordon Drive (at 2:10), north on Confederation Parkway and west on Hwy 5 (recording a level of 50 ug/m<sup>3</sup> opposite Stillmeadow at 2:30). Traverses of Hwy 5 revealed maximum levels of between 30 and 100 ug/m<sup>3</sup> between 2:30 and 4:00. The TAGA™ 3000 traversed Hwy 2 between Mississauga Road and Cawthra between 1:00 and 3:00, recording levels of 10 to 20 ug/m<sup>3</sup> in the plumes (located at Elmwood at 1:15 and Brant at 2:30). Between 3:00 and 4:00 a circle was made north on Cawthra, west on Atwater, north and west on Mineola, south on Hwy 10 and east on Hwy 2. The plume maximum was located at Eaglewood and Hwy 10, with a peak concentration of about 7 ug/m<sup>3</sup>.</p>
04:00	290	8	<p>At 4:15 the TAGA™ 2000 proceeded to the Command Center for a break, returning to monitoring at 5:30. Between 4:00 and 5:00 the TAGA™ 3000 continued to traverse Hwy 2, recording a maximum of 15 ug/m<sup>3</sup> in the plume at Woodlawn at 4:45. At 5:00 it proceeded north on Cawthra to Burnhamthorpe, west to Hwy 10 and south to Hwy 5. No chlorine was detected on this circuit. At 6:00, traverses were begun on Hwy 5 between Erindale Station Road and Mason Heights Road.</p>
07:00	310	4	<p>At 5:30 the TAGA™ 2000 returned to monitoring, proceeding east on Hwy 5 and crossing the plume just east of Mavis (100 ug/m<sup>3</sup>). The vehicle then proceeded south on Hwy 10, west on Hwy 2 (crossing the plume at John Street where the peak level was 8 ug/m<sup>3</sup>), north on Southdown Road and east on the QEW (17 ug/m<sup>3</sup> in the plume at the Credit River Bridge at 6:30). The circuit was repeated by travelling south on Hwy 10, west on Hwy 2 (14 ug/m<sup>3</sup> at John Street), north on Southdown Road and east on the QEW (43 ug/m<sup>3</sup> at the Credit River Bridge at 7:30). After reversing and crossing the plume once more on the QEW, the vehicle proceeded north on Mississauga Road to Hwy 5, east to Wolfedale and back to the Command Center at 8:30 for a personnel change. No chlorine was detected on the trip back. Meanwhile, in traversing Hwy 5, the TAGA™ 3000 measured maximum levels in the plume of about 70 ug/m<sup>3</sup> at 6:00 and 62 ug/m<sup>3</sup></p>

<u>TIME</u>	<u>WD</u>	<u>WS</u>	
			at 7:00 just east of Mavis. By 8:15 the level had increased to about 130 ug/m <sup>3</sup> at the same location, and at about 8:45 a maximum level of 85 ug/m <sup>3</sup> was recorded. The TAGA™ 3000 returned to the Command Center at 9:00.

09:00	325	7	<p>At 9:00 the TAGA™ 2000 returned to monitoring on Hwy 5. Chloroacetophenone was detected in the plume at 9:00, 10:00 and 11:00. Peak levels of 50 to 75 ug/m<sup>3</sup> of chlorine were measured during plume traversals in this interval, with the plume center located just east of Mavis. The TAGA™ 2000 continued monitoring on Hwy 5 while the TAGA™ 3000 returned from the Command Center to Hwy 2 at 10:30. The TAGA™ 3000 proceeded west on Hwy 2, crossing the plume at Benson ( 4 ug/m<sup>3</sup>). The vehicle then returned to the Fire Station on Port Street ( 1 block south of Hwy 2) and searched for chloroacetophenone at 11:15. None was detected. Two more traverses of the plume on Hwy 2 were performed, recording values of only 2 to 3 ug/m<sup>3</sup>, before proceeding north on Mississauga Road, west on the QEW (8 ug/m<sup>3</sup> 800 m west of Mississauga Road at 12:00), returning east to Mississauga Road, and north to Hwy 5 (crossing the plume at Mississauga Road and Shawanaga - 7 ug/m<sup>3</sup> at 12:25). Chlorine levels in the plume during this time were monitored by the TAGA™ 2000 on Hwy 5, where levels of 22 ug/m<sup>3</sup> at 12:00, 100 ug/m<sup>3</sup> at 12:30 and 50 ug/m<sup>3</sup> at 13:00 were measured.</p>
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13:00	300	1	<p>From 13:00 to 14:00 the TAGA™ 3000 traversed Hwy 5 between Cedarglen Court and Mason Heights, recording levels of about 18 ug/m<sup>3</sup> at 13:00. At 13:15 the calibrations of the two instruments were compared by parking them side by side in the plume. Both gave about the same chlorine levels, confirming that the response factors had not changed. From Hwy 5 the TAGA™ 2000 proceeded south on Mavis, east on the Queensway, south on Hwy 10, west on Harborn Road and Premium Way, and north on Stavebank and Mavis to Hwy 5. No chlorine was detected on this circuit. The TAGA™ 2000 proceeded to the Domtar brickyard (east of Mavis and north of Hwy 5) to monitor chlorine between 14:00 and 14:30. The plume was only observed once during this time when a level of 75 ug/m<sup>3</sup> was recorded (just after 14:00). The</p>
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<u>TIME</u>	<u>WD</u>	<u>WS</u>	
			TAGA™ 3000 meanwhile proceeded east on Hwy 5 at 14:00, south on Cawthra, west on Hwy 2 (plume maximum of about 2 ug/m <sup>3</sup> at Enola), north on Southdown Road to Hwy 5 and back to Mavis (50 ug/m <sup>3</sup> at 15:00 just east of Mavis). Between 15:00 and 21:00 a vacuum recycle was performed on TAGA™ 3000.

15:00	305	16	<p>Between 14:30 and 15:00 the TAGA™ 2000 monitored at the intersection of Mavis and Hwy 5, then proceeded east to Hwy 10, north to Burnhamthorpe, east to Tomken, back on Burnhamthorpe to Central Parkway, south and west to Hwy 10, south to Bloor, east to Cawthra, south to the QEW (at 16:00), west on the North Service Road to Hwy 10, north on Hwy 10 and west on the Queensway to Glengarry, where the peak level was 30 ug/m<sup>3</sup>. The vehicle proceeded north on Glengarry to Avongate, east on Avongate and Brigantine to Rosemary (where the level was 40 ug/m<sup>3</sup>) south to the Queensway, west to Glengarry, north to Hwy 5 and east to Mavis. The plume was detected just west of Mavis at about 17:10, with a maximum level of 120 ug/m<sup>3</sup>. Between 17:00 and 18:00 the TAGA™ 2000 monitored on Hwy 5, while the plume shifted from just west of Mavis to about 400 m east of the weigh station at 18:00 (when the maximum level was 40 ug/m<sup>3</sup>).</p>
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18:00	330	10	<p>From 18:00 to 22:00 the TAGA™ 2000 continued traversing Hwy 5, measuring peak chlorine concentration between 20 and 120 ug/m<sup>3</sup> in the plume. Between 22:00 and 23:00 the TAGA™ 2000 was calibrated with a certified mixture of Cl<sub>2</sub> in nitrogen. The TAGA™ 300 was then calibrated by parking the two vehicles side by side on Hwy 5 at Parkerhill Road (in the plume), and using the response factor from the TAGA™ 2000 to measure the ambient chlorine concentration (approximately 50 ug/m<sup>3</sup> at that time). At 24:00 the TAGA™ 3000 recorded a level of 25 ug/m<sup>3</sup> at Hwy 10 and the Queensway while the TAGA™ 2000 measured 90 ug/m<sup>3</sup> at Hwy 5 and Mason Heights.</p>
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November 15, 1979

00:00	280	1	<p>From 00:00 to 2:00 the TAGA™ 2000 continued traversing Hwy 5 while the TAGA™ 3000 traversed Hwy 10. Levels of 20 to 100 ug/m<sup>3</sup> were recorded in the plume on Hwy 5 while levels of</p>
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<u>TIME</u>	<u>WD</u>	<u>WS</u>	
			10 to 20 ug/m <sup>3</sup> were recorded at Hwy 10 and the Queensway. At 2:00 the chlorine concentration was measured between a height of about 4 m and the ground, as described in Section 3. The concentration was constant (within about 30% of 35 ug/m <sup>3</sup> ) over the distance. At about 2:30 the plume on Hwy 5 stretched between Mason Heights and Tomken, a width of about 5 km. The peak level measured on this traverse was only about 11 ug/m <sup>3</sup> . The next traverse on Hwy 5 (at 3:00) revealed no plume, as it had shifted toward the east. At 2:00 the TAGA™ 3000 travelled south on Hwy 10, (20 ug/m <sup>3</sup> ) just north of Sherobee, east on North Services Road (8 ug/m <sup>3</sup> and Munden Road as the plume shifted east)(, south on Cawthra to Hwy 2, back north on Cawthra, west on North Services Road, and north on Camilla to Hwy 5. No chlorine was detected on this return leg. The TAGA™ 2000 proceeded west on Hwy 5 to Cawthra and north to Burnhamthorpe, where the plume maximum was about 4 ug/m <sup>3</sup> . The vehicle proceeded north to Eglinton (detecting no chlorine) and then back south to Hwy 5 (crossing the plume between Bloor and Silver Creek Road: 4 ug/m <sup>3</sup> ), arriving at Hwy 5 and Cawthra at 5:00. After a one-half hour break, the TAGA™ 3000 returned to monitoring.
05:00	215	1	

At 3:45 the TAGA™ 2000 commenced monitoring on Hwy 10, recording a peak chlorine level of 35 ug/m<sup>3</sup> in the plume (now only about 450 m wide) at Fairview. The plume was continuously traversed on Hwy 10 until 6:00. The peak levels decreased from about 40 ug/m<sup>3</sup> at 4:00 to 9 ug/m<sup>3</sup> at 6:00, when the maximum was still located at about Fairview. At this time the plume had broadened to nearly 1.5 km. From 6:00 to 7:00 the TAGA™ 2000 completed two circuits of Mississauga Valley Boulevard, measuring peak values of about 5 ug/m<sup>3</sup> in the plume. Meanwhile the TAGA™ 3000 traversed Hwy 10 from Hwy 5 to Burnhamthorpe and west on Burnhamthorpe to Mavis, where complete positive and negative mode scans were performed. No unusual mass peaks were observed.

07:00	200	3	
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<u>TIME</u>	<u>WD</u>	<u>WS</u>	
08:00	205	7	Between 7:00 and 8:00 two complete circuits of City Center Drive were completed by the TAGA™ 2000. The plume maximum was located along the south section at about 7:30 (3 ug/m <sup>3</sup> ), but by 8:00 it had shifted to Burnhamthorpe and Arista Way (7 ug/m <sup>3</sup> ). The TAGA™ 2000 continued traversing Burnhamthorpe from City Center Drive to Cawthra between 8:00 and 9:00, measuring peak levels of between 1 and 6 ug/m <sup>3</sup> at Arista during the interval.
09:00	215	5	At 8:30 the TAGA™ 3000 proceeded south on Hwy 10 to the South Service Road, then back north to Burnhamthorpe, west to Wolfedale (arriving at 10:15), back east to Hwy 10, and south to Hwy 5. No chlorine was detected on this path. The TAGA™ 3000 continued to traverse Hwy 10 between Hwy 5 and Burnhamthorpe
12:00	210	11	until 12:00, while the TAGA™ 2000 monitored Burnhamthorpe between Cawthra and City Center Drive (including circuits of City Center Drive). No chlorine was detected by either instrument after 8:30.
13:00	240	10	From 12:00 to 13:00 the TAGA™ 3000 monitored Hwy 10 between Rathburn and Hwy 5, detecting no chlorine. Between 13:00 and 14:00 a break was taken. At 14:00 the TAGA™ 3000 proceeded south on Hwy 10 to Hwy 5, back north to Eglinton, south to Hwy 5, west to Mavis, back east to Cliff, west to Hwy 10 and north to Eglinton (arriving at 15:43). No chlorine was detected. During this time (from 12:00 to 15:00) the TAGA™ 2000 monitored on Burnhamthorpe (between City Center Drive and Cawthra, and on Cawthra between Hwy 5 and Burnhamthorpe. At 15:00 the TAGA™ 2000 proceeded south on Cawthra to Ardor Road (south of the QEW), and north on Cawthra to Burnhamthorpe. Traverses on
17:00	290	7	Cawthra were performed until 17:00.
			From 16:00 until 19:30 the TAGA™ 3000 continuously monitored on Hwy 10 between Burnhamthorpe and the QEW, detecting no chlorine. From 19:30 until 21:30 the gas load was removed from the vacuum system and a break was taken. At 17:00 the TAGA™ 2000 began traverses of Hwy 5, and twice detected a narrow plume or pocket of chlorine at Hwy 5 and Jaguar Valley Drive (4 ug/m <sup>3</sup> and 6 ug/m <sup>3</sup> at about 17:30). Subsequent traverses showed no chlorine. Monitoring continued on Hwy 5 until 20:30.

<u>TIME</u>	<u>WD</u>	<u>WS</u>	
21:00	340	14	From 21:00 to 23:00 both vehicles were prepared for monitoring during the pumping operation to remove chlorine from the ruptured tanker. Fully charged air packs were issued, the gasoline tanks were filled, emergency communication to the Command Center was arranged through a police escort with each vehicle, and the vehicles were driven to their starting location. At the beginning of the pumping operation (at 23:00) the TAGA™ 2000 began traverses of Hwy 5 between Mavis and Erindale Station Road while the TAGA™ 3000 began traverses on the QEW between Mississauga Road and Erin Mills Parkway. No plume was detected on Hwy 5 until about 23:15, when a narrow plume with a peak value of 1.5 ug/m <sup>3</sup> was observed at Wolfedale. This plume remained between Mavis and Wolfedale on Hwy 5, with values between 1 and 2 ug/m <sup>3</sup> while the TAGA™ 2000 continued traversals. No chlorine was detected by the TAGA™ 3000 on the QEW.
24:00	360	29	

November 16, 1979

00:00	350	25	The TAGA™ 2000 continued traversing Hwy 5 between Mavis and Erindale Station Road from 00:00 until 7:00. The plume center gradually shifted east from Wolfedale and Hwy 5 to Mavis and Hwy 5 by about 5:00. Peak values remained at 1 to 4 ug/m <sup>3</sup> until about 3:30, when they increased to 10 to 20 ug/m <sup>3</sup> . The plume remained at Mavis and Hwy 5 until about 7:30. During this time interval, the TAGA™ 3000 monitored on the QEW between Mississauga Road and Erin Mills Parkway. No plume was detected until about 3:30, when a value of 1.5 ug/m <sup>3</sup> was recorded about 1 mile east of Erin Mills Parkway. This level was maintained until 7:30.
03:00	000	15	
04:00	000	5	
06:00	350	0	

07:00	260	2	At about 7:30 the chlorine level at both locations (Hwy 5 and the QEW) dropped to below the detection limit. No wind was observed at this time. The TAGA™ 2000 began traversing Hwy 5 east to Hwy 10, and north on Hwy 10. A circuit was completed from Mavis and Hwy 5, east to Hwy 10, north to Burnhamthorpe, west to Wolfedale and south to Hwy 5. No chlorine was detected on this circle. Monitoring was then resumed on Burnhamthorpe between Mavis and Hwy 10, along Hwy 10 between Burnhamthorpe and
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<u>TIME</u>	<u>WD</u>	<u>WS</u>	
12:00	260	10	Hwy 5, and along Hwy 5 between Mavis and Hwy 10. At 12:00 the route was extended south to the South Service Road on Hwy 10, west on Hwy 2, north on Southdown Road, east on Truscott, north on Lorne Park, east on Indian Road and north on Mississauga Road to the QEW. No chlorine was detected (the last detection was at 7:30 on Hwy 5). The TAGA™ 3000 continued to traverse the QEW from 7:30 until 10:00, when it proceeded north on Hwy 10 to Fairview and west to Palgrave. From 10:00 to 12:00, continuous monitoring was performed north and south on Palgrave. At 12:00 the TAGA™ 3000 proceeded south on Hwy 10, west on the QEW, north on Erin Mills Road, to Burnhamthorpe, and then back south to Hwy 5, to Glengarry, south to the Queensway and east to Mavis. No chlorine was detected on this circuit, or on Palgrave.

At about 13:00 the TAGA™ 2000 proceeded north on Hwy 10 from the QEW to Hwy 5, west to Parkerhill, north to the end of Parkerhill and back south to Hwy 5. From 13:10 the vehicle monitored on Hwy 10 between Kirwin and Fairview (making the loop Fairview, Joan and Central Parkway at the north end). At 15:00, a narrow plume was detected on Hwy 10 and at Kirwin. Three passes were made in about 10 minutes. The maximum concentration was about 1.5 ug/m<sup>3</sup>. By 15:10 the plume had disappeared. Monitoring on Hwy 10 continued until 18:30, with no more chlorine detected. From 13:00 to 14:00 the TAGA™ 3000 traversed Hwy 5 between Hwy 10 and Wolfedale. At 14:00 it proceeded south on Mississauga Road to Indian Road, west to the South Service Road, east to Mississauga Road, north to Hwy 5 and back to the Command Center. A break was taken from 15:00 to 16:00. From 16:00 to 17:00 the TAGA™ 3000 monitored on Camilla, between Hwy 5 and the QEW, and from 17:00 to 18:50, on Hwy 10 between John and Paisley. No chlorine was detected.

19:00	250	20	At 18:50 the TAGA™ 2000 proceeded south on Hwy 10 to the Queensway, west to Gordon, south to Isabella, west to Parker, south to Harborn, east to Gordon and north to the Queensway. At 19:00 the vehicle travelled north on Gordon to the Queensway, west to Rosemary, north to Brigantine, west to Glengarry, south to Old Carriage Road, and north and west to Hwy 5. From 19:25 to 20:25 the TAGA™ 2000 remained stationary at the intersection
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<u>TIME</u>	<u>WD</u>	<u>WS</u>	
			of Old Carriage Road and Hwy 5. No chlorine was detected during this period. At 18:00 the TAGA™ 3000 began monitoring north on Erindale Station Road, west on Forestwood, north on Woodlands, Credit Woodlands, east and south on Queenstone, east and south on Fellmore, east on McBride and south on Erindale Station. No chlorine was detected.

20:00	255	20	From 20:00 to 24:00 a vacuum recycle was performed on the TAGA™ 3000. The TAGA™ 2000 remained stationary at Wolfedale and Hwy 5 from 20:25 until 21:15, when traverses were started along Hwy 5 and south on Hwy 10 to the Queensway. At about 23:00 the route was extended to Burnhamthorpe, and monitoring continued on Hwy 10 between Fairview and Burnhamthorpe, and west on Burnhamthorpe to City Center Drive. No chlorine was detected during this period.
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November 17, 1979

00:00	260	20	From 00:00 to 9:30, the TAGA™ 2000 travelled north and south on Joan Street, between Hansen and Elm. No chlorine was detected. During this period (from 00:00 to 7:00) the TAGA™ 3000 monitored on Parkerhill between the Railway tracks and Hwy 5,
07:00	265	15	also detecting no chlorine. From 7:00 to 15:00 another vacuum recycle was performed.

The TAGA™ 2000 continued monitoring on Hwy 10 between Central Parkway and Paisley from 9:30 to 14:30. No chlorine was detected during this period. At 14:00 the vehicle returned to the Command Center to exchange personnel.

14:00	300	15	At 14:30 the TAGA™ 2000 returned to monitoring on Hwy 5 between Wolfedale and Kerwin (just east of Hwy 10). From 15:50 to 16:20 the vehicle was again at the Command post, returning to Hwy 5 from 16:20 to 17:00. From 17:00 to 18:15 monitoring was performed on Wolfedale, between the Railway tracks and Hwy 5.
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16:00	330	5	At 16:00 the TAGA™ 3000 returned to monitoring on Hwy 5 between Wolfedale and Hwy 10. One of the generators required servicing between 19:00 and 22:00, necessitating another vacuum recycle from 22:00 until 5:00 on November 18. No chlorine was detected by either vehicle on November 17.
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TIME    WD    WS    November 18, 1979

00:00 305    5    At 00:30 the TAGA™ 2000 returned to monitoring after completing a vacuum system regeneration. The vehicle travelled a circuit composed of Burnhamthorpe, Wolfedale, Hwy 5 and Erindale Station Road, completing the circle five times by 2:00. No chlorine was detected. From 2:00 to 3:20, Hwy 5 was repeatedly traversed between Wolfedale and Hwy 10. No chlorine was observed, and positive and negative mode scans obtained at about 2:50 at Mavis and Hwy 5 showed no other unusual compounds.

At 3:20 the TAGA™ 2000 moved to a site on Mavis, a few hundred feet south of the Railway tracks, and positive and negative mode scans were obtained. Several small mass peaks were observed but not identified. They were probably associated with the odor of diesel fumes, which was noted. At 4:25 the vehicle returned to monitoring on Hwy 5, and at 5:00, it returned to the Command Center.

05:00 290    0    At 5:00 the TAGA™ 3000 returned to monitoring. From 5:00 until 7:30 it traversed west on Hwy 5 between Hwy 10 and Erindale Station Road, and north on Erindale Station Road. No chlorine was detected. At 7:30 the vehicle proceeded north on Erindale Station Road to Burnhamthorpe, east on Burnhamthorpe to Hwy 10 and south to Hwy 5. Monitoring then resumed on Hwy 5.

10:00 130    3    At 10:00 both the TAGA™ 2000 and the TAGA™ 3000 were instructed to proceed to a site on Mavis Road just south of the Railway tracks for photographs. At 12:00 the TAGA™ 3000 returned to monitoring on Hwy 5 between Mavis and Hwy 10, and on Hwy 10 between Hwy 5 and Paisley. The TAGA™ 2000 returned to the Command Center. It had become apparent that one of the ion focussing lenses was behaving irregularly (the trouble first appeared at about 9:00), and troubleshooting procedures continued at the Command Center. The eventual solution to the problem, which was associated with a non-conducting layer on the lens surface inside the vacuum chamber, was to recycle the vacuum system and perform another pump down. This was begun at about 16:00.

<u>TIME</u>	<u>WD</u>	<u>WS</u>	
12:00	120	5	<p>The TAGA™ 3000 continued monitoring on Hwy 5 and Hwy 10 from 12:00 until 14:00, when it moved to begin traverses on Burnhamthorpe between Erindale Station Road and Hwy 10. Fog had moved in at about 12:00, and it continued until the next day. Continuous traverses were performed until 15:00, when stationary monitoring was commenced at the intersection of Mavis and Burnhamthorpe. During this period (from 12:00 to 15:00), low levels of <math>\text{Cl}^-</math> were detected. However, repeated checks at the mass peaks corresponding to <math>\text{Cl}_2^-</math> showed the complete absence of this ion, which was always present when chlorine was detected on previous days (see Section 2.7). Therefore, it was concluded that some other chlorinated compound (perhaps a chlorinated solvent) was in the air from another source. No definite plume structure was observed for this spurious compound, so that there was no way of identifying the source. Full mass scans (positive and negative) failed to show the presence of any other chlorinated compounds.</p>
17:00	090	5	<p>At 17:00 the vehicle moved to Hwy 5, and began monitoring between Hwy 10 and Erindale Station Road. The traverses were changed to a closed circle at 19:00, running north on Erindale Station Road to Burnhamthorpe, east to Hwy 10, south to Hwy 5 and west back to Erindale Station Road. The <math>\text{Cl}^-</math> ion was again detected, but without the presence of <math>\text{Cl}_2^-</math>. Therefore, chlorine gas was not the source. The TAGA™ 3000 continued monitoring on Hwy 5, Erindale Station Road, Burnhamthorpe and Hwy 10 until 23:00 when it returned to the Command Center.</p>
23:00	080	5	<p>At 21:00 the TAGA™ 2000 had returned to monitoring, traversing north and south on Wolfedale between the Railway tracks and Hwy 5 until 24:00. The <math>\text{Cl}^-</math> ion was also observed with this system, again in the absence of <math>\text{Cl}_2^-</math>. Full mass scans showed a relatively high level of <math>\text{SO}_2</math>, but no other unusual mass peaks.</p>

November 19, 1979

Fog continued throughout the night until the mid morning. At 00:00 the TAGA™ 3000 returned to monitoring on Wolfedale, Hwy 5, Erindale Station Road and Burnhamthorpe. Both vehicles continued on this route until 8:00, both detecting  $\text{Cl}^-$

<u>TIME</u>	<u>WD</u>	<u>WS</u>	
10:00	100	0	(but no $\text{Cl}_2^-$ ) on occasion. At 8:00 the TAGA™ 3000 returned to the Command Center, while the TAGA™ 2000 continued monitoring. At 10:00 the MOE ended all monitoring operations, the TAGA™ 2000 returned to the Command Center, and both vehicles returned to SCIEX by 13:00.

### 3.2 DETECTION OF OTHER ORGANIC COMPOUNDS

Chloroacetophenone was detected in the plume, and shown to be identified with it by traversing the plume while monitoring  $m/z=155$  (the strongest isotope). Detection of this compound was usually associated with strong eye irritation while in the plume. No calibration was performed, since no pure sample was available. However, a calibration for acetophenone (expected to be similar in sensitivity) showed a detectability of less than 0.1 ppb. If the response factor for chloroacetophenone is assumed to be the same as that for acetophenone, the maximum levels detected were of the order of 2 to 3 parts-per-billion, or 10 to 20  $\mu\text{g}/\text{m}^3$  (measured on November 12 at about 11:00 on Wolfedale south of the Railway tracks).

The other species which have been tentatively identified from the mass spectra acquired in the plume are listed below, with the time and location of their observation. In some cases a mass peak may be due to more than one compound, and where identification is not certain, both possibilities are listed. Only these instances where the mass spectra revealed the presence of mass peaks significantly above the background level are discussed below.

#### November 11, 1979

17:10 at the Domtar brickyard (Mavis north of Hwy 5). No unusual peaks were observed in the positive mode. In the negative mode, a small peak which could have been due to styrene glycol was detected.

November 12, 1979

10:00 at Glengarry and Hwy 5. Toluene and xylene were apparently present, while methyl styrene and acetophenone were tentatively identified. Chloroacetophenone was detected for the first time in this mass scan.

November 12, 1979

11:00 at Wolfedale just south of the Railway tracks. Toluene and xylene were again present, and chloroacetophenone was at the highest concentration detected during the monitoring program. Other compounds tentatively identified were hydroxyacetophenone and chlorostyrene.

November 12, 1979

19:50 at Mavis and Hwy 5. Xylene and acetophenone, but not chloroacetophenone were detected.

November 12, 1979

21:40 at Hwy 5 and Mavis. Xylene and methyl acetophenone were tentatively identified in the positive ion spectrum.

November 13, 1979

00:00 at Wolfedale and Hwy 5. Xylene, methyl acetophenone, and styrene glycol were all tentatively identified, along with two mass peaks in the negative mode ( $m/z = 119$  and  $121$ , not in the proper ratio for chlorine isotopes) which were unidentified.

November 15, 1979

At 3:15 Hwy 10 and King Street. This spectrum was acquired outside the Cable 10 office in response to a complaint about a strange odor. No chlorine was observed, but there was a significant although not unusually high level of  $SO_2$ . In the

positive mode, a mass peak at  $m/z = 83$ , (tentatively identified as methyl furan or methyl pyroazole) was observed.

All of the peaks are identified only tentatively, except for that due to chloroacetophenone, which seems quite firmly established because of the isotope distribution showing one chlorine atom, and the known lachrymating character of this compound. Most peaks are only two to five times as high as other peaks in the spectra, and therefore appear to be only somewhat above the detection limits. Table 1 shows a list of the compounds tentatively identified, along with their TLV (threshold level value) where known, and the approximate detection limit of each with the TAGA™. In most cases, no calibration has been performed, and the detection limits have been established based on the detection limits of other compounds which have similar ionization properties. However, it is apparent that none appeared to be close to the level which would be considered unacceptable in a work space environment.

LEGEND FOR TABLE 2

Date:

Time:

Location of Plume Center: The approximate location of the center of the plume at each hour of the day.

Chloroacetophenone Detected: ✓ indicates that chloroacetophenene was detected.  
- indicates that it was either not looked for or not detected.

[Cl<sub>2</sub>] maximum Plume:  
(ug/m<sup>3</sup>) The highest chlorine concentration recorded during one traverse of the plume.

Distance from Source: Distance from location of the plume center to the site of the derailment.

Comments:

TABLE 2

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{\max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 11	13:00	No plume was detected	-	-	-	
	14:00	Queensway E of Mavis	-	20	1.8	
	15:00	Mavis and Hwy 5	-	80	0.76	
	16:00	Mavis and Hwy 5	-	63	0.76	
	17:00	Domtar Brick Plant	-	35	0.83	
	18:00	Domtar Brick Plant	-	80	0.83	
	18:40	Domtar Brick Plant	-	150	0.83	
	20:00	Hwy 10 and RR Tracks	-	2	2.1	
	21:00	Hwy 10 and RR Tracks	-	3	2.1	
	22:00	Hwy 10 and Paisley	-	2	2.4	
	23:00	Hwy 10 and Queensway	-	4	2.6	



DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 12	00:00	-	-	-	-	
	01:00	20m E of Mavis on Queensway	-	11	1.8	
	02:00	At Mavis and Highway 5	-	42	0.76	
	03:00	Hwy 5 10m W of Mavis	-	75	0.76	
	04:00	Hwy 5 about 10-20m W of Mavis Huron Park	- -	70 28	0.76 1.3	
	05:30	Hwy 5 between Wolfdale and Mavis	-	27	0.85	
	06:00	Hwy 5 and Wolfdale	-	300	0.9	
	06:15	Hwy 5 and Wolfdale	-	75	0.9	
	07:00	Queensway E of Glenarry	-	10	2.2	
	08:00	Hwy 5 and Wolfdale	-	10	0.9	
	09:00	Hwy 5 and Wolfdale	-	27	0.9	Eye irritation in Plume.
	10:00	Wolfdale just N of Hwy 5 Hwy 5 and Glenarry	- ✓	30 -	0.83 1.5	Eye irritation in Plume.

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 12	10:15	Wolfdale S of RR Tracks	✓	-	0.4	Eye irritation in Plume.
	11:00	Hwy 5 just W of Wolfdale	-	30	1	
		Erindale Stn Rd & Forestwood	-	5	1.3	
	12:00	Wolfdale just N of Hwy 5	-	36	0.83	
	13:00	Wolfdale and RR Tracks	-	14	0.4	
	14:00	Hwy 5 between Wolfdale and Mavis	-	3	0.83	
	15:00	Cement plant opposite Command Center	-	20	0.5	
	16:00	"	-	50	0.5	
	16:15	"	✓	-	0.5	
	17:00	-	-	-	-	
	18:00	-	-	-	-	
	19:00	-	-	-	-	
	20:00	Hwy 5 between Wolfdale and Mavis	✓	-	0.9	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 12	21:00	Wolfdale N of Hwy 5	-	140	0.9	
	22:00	-	-	-	-	
	23:00	Forestwood Dr. and Wolfdale	-	>400	0.6	
	23:30	"	-	350	0.6	
Nov. 13	00:00	Wolfdale and Forestwood Dr.	-	>400	0.6	
	01:00	Highway 5 and Cedarglen gate	-	150	1.1	
	02:00	Along Wolfdale	-	140	0.6	
	03:00	Wolfdale and Westlock Rd.	-	170	0.45	
	04:00	Wolfdale and Forestwood Dr.	-	80	0.6	
	05:00	Highway 5 and Cedarglen gate	-	100	1.1	
	06:00	Wolfdale and Forestwood Dr.	-	170	0.6	
	07:00	Cedarglen gate and Highway 5	-	125	1.1	
	08:00	Wolfdale 450m S of RR Tracks	-	55	0.5	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 13	09:00	-	-	-	-	
	10:00	-	-	-	-	
	11:00	-	-	-	-	
	12:00	Hwy 5 and Wolfdale	-	300	0.9	
	13:00	Wolfdale between Hwy 5 and RR Track	-	300	0.76	
	14:00	Queensway and Rosemary	-	14	2	
	15:00	Mississauga Rd. & N Sheridan Way	-	7	2.9	
	16:00	Hwy 5 at Wolfdale	-	75	0.9	
	17:00	QEW West of Mississauga Rd. Hwy 5 at Wolfdale	- -	20 80	3 0.9	
	18:00	QEW W of Mississauga Rd. Hwy 5 at Wolfdale	- -	21 80	3 0.9	
	19:00	-	-	-	-	
	20:00	Hwy 5 E of Mavis Hwy 2 at Briarwood	- -	90 5	0.83 5.1	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 13	21:00	Hwy 5 just E of Mavis	-	70	0.83	
	22:00	Hwy 5 E of Mavis	-	70	0.83	
		Hwy 2 at RR Tracks (near Harrison)	-	37	4.8	
	23:00	Hwy 5 and Crystalburn	-	85	0.9	
Nov. 14	23:30	Hwy 2 and Helen	-	14	4.9	
	00:00	Highway 5 and Mavis	-	85	0.83	
	01:00	Highway 5 and Mavis	-	200	0.83	
	01:15	Hwy 2 and Elmwood	-	7	5	
	02:00	Queensway and Gordon	-	40	2.1	
	03:00	Hwy 5 opposite Crystalburn	-	50	0.9	
	04:00	Hwy 5 opposite Crystalburn	-	70	0.9	
	04:45	Hwy 2 and Woodlawn	-	15	5.2	
	05:00	-	-	-	-	
	06:00	Hwy 5 200m E of Mavis	-	70	0.9	
		Hwy 2 at John St.	-	15	4.8	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 14	07:00	Hwy 2 and John St. Hwy 5 160m E of Mavis	- -	17 63	4.8 0.9	
	08:00	QEW just E of Credit River	-	19	2.8	
	08:15	Hwy 5 200m E of Mavis	-	136	0.9	
	09:00	Hwy 5 just E of Weigh Scales	✓	75	0.9	
	10:00	Hwy 5 E of Weigh Scales	✓	40	0.9	
	11:00	" Hwy 2 at Benson	✓ -	60 4	0.9 4.7	
	12:00	Hwy 5 just W of Wolfdale	-	22	1.1	
	13:00	Hwy 5 at Mavis	-	50	0.8	
	14:00	Hwy 5 just E of Mavis	-	70	0.8	
	15:00	Hwy 5 just E of Mavis	-	50	0.8	
	16:00	-	-	-	-	
	17:00	Queensway and Rosemary	-	28	2	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 14	17:15	Hwy 5 and Woldale	-	120	0.9	
	18:00	Hwy 5 just E of Weigh Station	-	43	0.83	
	19:00	Hwy 5 just E of Mavis	-	70	0.83	
	20:00	Hwy 5 and Weigh Station	-	74	0.8	
	21:00	Hwy 5 and Weigh Station	-	100	0.8	
	22:00	Hwy 5 at Parkerhill	-	85	1.5	
	23:00	Highway 5 between Mason Heights and Parkerhill	-	63	1.45	
Nov. 15	00:00	Hwy 5 and Mason Heights	-	90	1.4	
		Hwy 10 just N of Queensway	-	25	2.5	
	01:00	Hwy 5 just W of Mason Heights	-	56	1.2	
	02:00	Parkerhill Rd. and Hwy 5 N Service Rd. and Cliff	-	42	1.5	
			-	8	3.9	
	03:00	Hwy 5 between Hwy 10 and Rugby	-	28	2	
	03:45	Fairview and Hwy 10	-	39	2.1	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 15	04:00	Burnhamthorpe and Cawthra	-	3	4.4	
	05:00	Hwy 10 between Kerwin and Central Parkway	-	17	2	
		Cawthra between Bloor and Silver Creek Rd.	-	3	4.1	
	06:00	Hwy 10 between Kervin and Fairview	-	5	2	
	07:00	Hwy 10 and Burnhamthorpe	-	7	2.5	
	08:00	Hwy 10 and Central Pkwy	-	7	2.2	
	09:00	No plume detected	-	-	-	
	10:00	No plume detected	-	-	-	
	11:00	"	-	-	-	
	12:00	"	-	-	-	
	13:00	"	-	-	-	
	14:00	"	-	-	-	
	15:00	"	-	-	-	
	16:00	"	-	-	-	



DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[C1_2]_{\max}$ IN PLUME ( $\mu\text{g}/\text{m}^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov 15	17:00	Highway 5 and Jaguar Valley Rd.	-	4	2.4	
	18:00	No plume was detected	-	-	-	
	19:00		-	-	-	
	20:00	MONITORING ON HWY 5, HWY 10 AND THE QEW	-	-	-	
	21:00		-	-	-	
	22:00		-	-	-	
	23:00		-	-	-	
	23:30	Hwy 5 at Wolfdale	-	1.5	0.9	
Nov. 16	00:00	Hwy 5 between Mavis and Wolfdale	-	3	0.83	
	01:00	"	-	4	0.83	
	02:00	"	-	4	0.83	
	03:00	Hwy 5 and Wolfdale	-	7	0.9	
	04:00	" QEW 1.6km E of Erin Mills Rd.	- -	12 1.5	0.9 4	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 16	05:00	Hwy 5 and Mavis QEW 1.3km W of Mississauga Rd.	- -	10 1	0.8 4	
	06:00	Hwy 5 and Mavis QEW 1.3km W of Mississauga Rd.	- -	15 1	0.8 3.5	
	07:00	Hwy 5 between Mavis and Wolfedale QEW 800m W of Mississauga Rd.	- -	17 1	0.83 3	
	08:00	No plume was detected	-	-	-	
	09:00		-	-	-	
	10:00		-	-	-	
	11:00	MONITORING ON HWYS FROM MAVIS TO HWY 10, HWY 10 FROM BURNAMTHORPE TO HWY 5, AND ON THE QEW BETWEEN MISSISSAUGA RD. AND HWY 10.	-	-	-	
	12:00		-	-	-	
	13:00		-	-	-	
	14:00		-	-	-	
	15:00	Hwy 10 at Kirwin	-	1	2	
	15:20	No Plume was detected	-	-	-	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 16	16:00	No plume was detected	-	-	-	
	17:00		-	-	-	
	18:00		-	-	-	
	19:00	Gordon Rd. S of Queensway	-	1	2.4	
	20:00	No plume was detected	-	-	-	
	21:00		-	-	-	
	22:00		-	-	-	
	23:00		-	-	-	
Nov. 17	00:00	MONITORING ON PALGRAVE, PARKERHILL AND HWY 10.	-	-	-	
	01:00		-	-	-	
	02:00		-	-	-	
	03:00		-	-	-	
	04:00		-	-	-	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 17	05:00	No plume detected	-	-	-	
	06:00		-	-	-	
	07:00		-	-	-	
	08:00		-	-	-	
	09:00		-	-	-	
	10:00	MONITORING ON HWY 10, HWY 5, WOLFDAL AND PARKERHILL.	-	-	-	
	11:00		-	-	-	
	12:00		-	-	-	
	13:00		-	-	-	
	14:00		-	-	-	
	15:00		-	-	-	
	16:00		-	-	-	
	17:00		-	-	-	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 17	18:00	No plume was detected	-	-	-	
	19:00		-	-	-	
	20:00		-	-	-	
	21:00		-	-	-	
	22:00		-	-	-	
	23:00	MONITORING ON HWY 5, HWY 10, BURNHAMTHORPE AND WOLFDAL.	-	-	-	
	24:00		-	-	-	
Nov. 18	00:00		-	-	-	
	01:00		-	-	-	
	02:00		-	-	-	
	03:00		-	-	-	
	04:00		-	-	-	
	05:00		-	-	-	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[C1_2]_{\max}$ IN PLUME ( $\mu\text{g}/\text{m}^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 18	06:00	No plume was detected	-	-	-	
	07:00		-	-	-	
	08:15		-	-	-	
	09:00		-	-	-	
	10:00	MONITORING ON HWY 5, HWY 10 AND BURNHAMTHORPE.	-	-	-	
	11:00		-	-	-	
	12:00		-	-	-	
	13:00		-	-	-	
	14:00		-	-	-	
	15:00		-	-	-	
	16:00		-	-	-	
	17:00		-	-	-	
	18:00		-	-	-	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 18	19:00	No plume was detected	-	-	-	
	20:00		-	-	-	
	21:00		-	-	-	
	22:00		-	-	-	
	23:00		-	-	-	
Nov. 19	24:00	MONITORING ON HWY 5, ERINDALE STATION RD. BURNHAMTHORPE AND WOLFDALÉ.	-	-	-	
	00:00		-	-	-	
	01:00		-	-	-	
	02:00		-	-	-	
	03:00		-	-	-	
	04:00		-	-	-	
	05:00		-	-	-	
	06:00		-	-	-	

DATE	TIME	LOCATION OF PLUME CENTER	CHLORO- ACETO- PHENONE DETECTED	$[Cl_2]_{max}$ IN PLUME ( $\mu g/m^3$ )	DISTANCE FROM SOURCE (km)	COMMENTS
Nov. 19	07:00	No plume was detected	-	-	-	
	08:00	"	-	-	-	
	09:00	"	-	-	-	
	10:00	"	-	-	-	



FIGURE 1



MISSISSAUGA, AMBIENT AIR MONITORING  
NOVEMBER, 1979

#### REFERENCES

1. Mississauga Derailment - Time-Averaged Ground-Based Meteorological Data. Ontario Ministry of the Environment, Report ARB-TDA #04-80 (1980).
2. Development of Methodologies for the Analysis of Polychlorinated Biphenyls (PCBs) in Air Using the TAGA™ Systems. Report prepared for the Ontario Ministry of the Environment, by SCIEX INC. (1979).
3. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1978. American Conference of Governmental Industrial Hygienists.
4. Verschuërer, K., Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Company, New York (1977).

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